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A TRUE STORY OF OLD BABYLON.

By Theo. G. Pinches, M.R.A.S., *Department of Egyptian and Assyrian Antiquities, British Museum.*

ACCORDING to the accounts and data that have been handed down to us, Babylon, the capital of the ancient realm of Babylonia, was the largest and one of the most magnificent of the cities of ancient times. Though its area greatly exceeded that of London, it is nevertheless doubtful whether the number of its inhabitants, even during its most prosperous days, reached anything like a million souls. Within the walls, however, were large tracts of cultivated ground, where produce of all kinds, especially grain and dates, was grown, providing sustenance for a large population; and it is probable that no siege, however long, could have starved the city into surrender. How Babylon was at last captured by draining the Euphrates we all know. Had the skill to defend the city been there when the Persians, on that fatal night of the 11th of Marcheswan, entered the city, and the son of the king died, the power of the native rulers would probably have lasted much longer than was really the case.

How far we must go back to reach the beginnings of the great city, it is impossible to estimate. All that can be said is, that it came into prominence about 2300 B.C., and was probably, even at that date, a place of considerable importance. To the whole Assyrian-speaking world, even the Assyrians, who were often the enemies of the Babylonians, it seems to have been a place of romance, for it was the seat of the worship of Merodach, the chief of the gods, and the capital of the country wherein had taken place of old all the wonderful things told of their gods and heroes and men of renown. To them all it was "the seat of life"* and "the gate of God,"† but to the native Babylonian it was more than all this—it was the seat of the empire, a great city of celebrated fanes and temples, with many a mystic rite and belief—"the glory of kingdoms, the beauty of the Chaldees' excellency." Many a life of joys and sorrows, of happiness and of pathos and of tragedy, has been lived under the shadow of the great towers of Babylon and Borsippa, on the site of whose busy streets reigns now only silence—the silence of a place utterly forsaken of men. From time to time this quiet of the tomb is broken for a while by the pick of the excavator, raising to startling lifelikeness many a ghost of bygone ages to haunt the world—and then, again silence and desolation.

A House-sale at Babylon.—It was winter at Babylon in the year 553 B.C. Nabonidus, the father of Belshazzar, had been king for two years, and peace and commercial prosperity filled the land. A little knot of about eight persons had assembled for a not uncommon business transaction, namely, the selling of a house and orchard. There were the seller, the representative of the buyers, four witnesses, one of whom was Iddina-Marduk the money-lender, and two scribes, Kapti-îlāni-Marduk and Nabû-zēr-lîsir, who, if they wrote the document now extant,‡ must henceforth be regarded as having been, in their time, past-masters in the art of beautiful writing.

The property sold consisted of a house and plantations at Borsippa, a city which was, at this time, practically a suburb of Babylon, and was renowned for its great temple-tower, named Ê-zida.§ The extent of the property is given as "7 canes, 5 cubits, 18 fingers," and it was disposed of for 11⅔ manehs of silver. It was a man named Ibâ who was purchasing the property of its owner, Dâan-sum-iddina, but he merely transacted the affair by the authority of Abil-Addu-natanu and his wife Bunanitum (also spelled Bunanitu and Bunanit), who were now the real owners of the property. Ibâ took possession of the house and paid the money. As for Dâan-sum-iddina, he had henceforth no part in the property, for he had sealed the deed with his name, and had given it to Abil-Addu-natanu and Bunanitum. The copy of the seal of the two absent purchasers having been examined and pronounced to be genuine, the names of the witnesses and scribes, which latter impressed their seals, were added, completing the document. The date is "Babylon, month Sebat, day 24th, year 2nd, Nabû-na'id (=Nabonidus), King of Babylon."

The Loan to make up the Purchase-money.—One of the witnesses to the above, Iddina-Marduk, son of Ikîsā, son of Nûr-Sin, has already been mentioned. He it was who advanced to the couple a sum sufficient to make up the amount required to pay the purchase-money. Whether he had advanced the amount as a friend, or had had an agreement drawn up, we do not know, but as at the end of two years and three months the loan was still unpaid, Iddina-Marduk, being a real man of business, had a tablet drawn up to the following effect:—

* In Akkadian *Tintir*, in Assyrian *sobath balati*, "Babylon, the seat of life" (generally transcribed *Bâbilu, subat balati*) being given as Βαβιλ σοβαθα β[αλατι] during the Greek period.

† In Akkadian *Ka-Dingirra*, in Assyrian *Bâbili* or Babel.

‡ See the reproductions (obverse and reverse) illustrating this paper.

§ Regarded by many as the Tower of Babel.

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"1⅓ mana 8⅓ shekels (=1 mana 38⅓ shekels) of silver from Iddina-Marduk, son of Ikîsâ, son of Nûr-Sin, unto Abil-Addu-natanu, son of Addi-Ya, and Bunanitum his wife. Each mana increases unto them monthly by one shekel. From the 1st day of the month Sivan, of the 5th year of Nabonidus, King of Babylon, they shall pay the amount pledged. The silver was the balance of the money which was given to Ibâ as the price of the house. They shall pay monthly the amount pledged.

"Witnesses: Ê-zida-sum-ibnî, son of Nabû-sum-usur, descendant of La-kubburu; Nabû-âkhê-bullit, son of Marduk-sum-usur, descendant of the Sukhite; and the scribe, Ablâ, son of Musallim-Marduk. Borsippa, month Iyyar, day 3rd, year 5th, Nabonidus, King of Babylon."

Yet this contract, apparently so solemnly undertaken, and here so circumstantially recorded, and existing in at least two copies, remained practically a dead letter for nearly four years more—that is to say, there is no record of either principal or interest having been paid for six years. Possibly bad times came to Abil-Addu-natanu and his wife—indeed, it is not impossible that a long illness may have preceded his death, which took place before the end of the eighth year of Nabonidus. Of the interval, however, we have at present no account.

AN INSTALMENT OF THE LOAN REPAID.—To the credit of the widowed Bunanitum be it said, that she did her best

Obverse of the tablet recording the sale of a house at Borsippa to Ibâ, for Abil-Addu-natanu and his wife, in the second year of Nabonidus (553 B.C.).

to fulfil, after her husband's death, her part of the contract; for, in the eighth year of Nabonidus, she paid nine shekels of silver as part of the interest, as recorded by the following document:—

"9 shekels of silver, the amount of the first payment, Iddina-Marduk, son of Ikîsâ, son of Nûr-Sin, has received, as the interest of his money, from the hands of Bunanitum, after the death of Ablada-natunu (=Abil-Addu-natanu), her husband. In the presence of Tabnêa, son of Nabû-âkhê-iddina, son of the priest of Ea (?); Nabû-kain-abli, son of Marduk-sum-ibnî, son of Dan-Nabû. Barsip (=Borsippa), month Adar, day 18th, year 8th, Nabonidus, King of Babylon." (A negative phrase follows, which probably corresponds to our "without prejudice.")

THE LAWSUIT.—It was not until the property of Bunanitum came before what probably corresponded to our "chancery court," however, that Iddina-Marduk received back all his money. How long he might have had to wait if Bunanitum had not brought an action to restrain her brother-in-law from taking possession of her property is hard to guess. Two copies of the action (neither of them the original sealed reports) exist. The text reads as follows:—

"Bunanitum, daughter of Hariza, said thus to the judges of Nabonidus, King of Babylon: 'Abil-addu-natan, son of Nikmadu, had me to wife, taking three mana of silver as dowry, and I bore to him one daughter. I and Abil-addu-natan, my husband, traded with the money of my dowry, and we bought, for 9⅓ mana of silver, with 2½ mana of silver which was from Iddina-Marduk, son of Ikîsâ, son of Nûr-Sin, which we added to the former sum, 8 canes of land and a small house, the territory of a large property, which was within Borsippa. We carried out this transaction together in the 4th year of Nabonidus, King of Babylon.

"Now Abil-Addu-natan, my husband, had my dowry. I asked (for it), and Abil-Addu-natan, my husband, in the kindness of his heart, sealed and bequeathed to me for future days the 8 canes of land, and that house, which is within Borsippa, and made it known on my tablet as follows: '2½ mana of silver, which Abil-Addu-natan and Bunanit took from Iddina-Marduk and gave as the price of that house—together they have made the agreement.' He sealed this tablet, and wrote upon it the curse of the great gods.

"In the 5th year of Nabonidus, King of Babylon, I and Abil-Addu-natan, my husband, adopted Abil-Addu-amara, and wrote the tablet of his adoption; and we announced that the dowry of my daughter Nubtâ was 2 mana 10 shekels of silver and the furniture of a house. Fate took my husband, and thereupon Akabi-ilu, son of my father-in-law, laid claim upon the house and everything that he had sealed and bequeathed to me, and upon Nabû-nûr-îli, whom we had bought from the hands of Nabû-akhê-iddina, for money. I have brought it before you—make a decision.

"The judges heard her words, they read the tablets and documents that Bunanitu had brought before them, and they did not let Akabi-îlu have power over the house at Borsippa, which had been bequeathed to Bunanitu instead of her dowry; over Nabû-nûr-îli, whom she and her husband had bought for money, nor over anything of Abil-Addu-natan. Bunanitu and Abil-Addu-amara, by their tablets, possess (them). Iddina-Marduk agrees to and receives the 2½ mana of silver which had been given as the price of that house. Afterwards Bunanitum receives 3⅓ mana of silver, her dowry; and besides her share, Nubtâ receives Nabû-nûr-îli, according to the contracts of her father.

By the decision of this judgment.
Nergal-banunu, judge, son of the Rab-banî.
Nabû-âhê-iddina, judge, son of Egibi.
Nabû-sum-ukîn, judge, son of Ir(?)ani.
Bêl-ahê-iddina, judge, son of . . . . .
Bêl-etir, judge, son of . . . . .
Nabû-balat-su-ikbi, judge, son of . . . . .
Nadinu, scribe, son of . . . . .
Nabû-sum-iskun, scribe, son of the . . . . .
Babylon, month Elul, day 26th, 9th year of Nabonidus, King of Babylon."

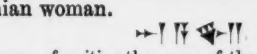
With this favourable decision—undoubtedly just from every point of view—the troubles of Bunanitum in all probability came to an end; and we may suppose that she lived for the rest of her days happily with Nubtâ, her daughter, and Abil-Addu-amara, her son-in-law, served by the old slave that she and her husband had bought in times long past.

The whole story gives an accurate picture of life in Babylon during the later Babylonian empire—that founded, apparently, by Nabopolassar, the father of Nebuchadnezzar. This dynasty came to an end with Nabonidus and his son Belshazzar, after whose death Cyrus came to the throne. The prosperity inaugurated by

the reign of Nabopolassar continued to increase during the time of his successors, and was so firmly established that the conquest of the country by Cyrus and his general, Gobryas, hardly interrupted it. The inscriptions translated above, therefore, belong to a period of unexampled prosperity, and are only specimens of many thousand similar texts, all of them important for the manners, customs, and chronology of the time. They show how

Reverse of the same tablet, showing the impressions of the seals of the scribes.

ceaseless was the business activity and commercial enterprise of the Babylonians ; and the texts above translated indicate to us that then, as now, the commercial prosperity of a country attracted foreigners, who settled there and became as the natives of the land. Both Abil-Addu-natanu and his foster-son Abil-Addu-amara were foreigners, most likely from Syria, and in their own country must have borne the names of Ben-Hadad-nathan and Ben-Hadad-amara respectively. Bunanitum, however, was evidently a Babylonian woman.



One of the ways of writing the name of the god Abil-Addu ("the son of Hadad"), the Ben-Hadad of the Syrians.

It will probably be some time before we get sufficient data to enable us to realize the full extent of the intercourse in ancient times between Mesopotamia and the west, but it was probably much greater than we suppose it to have been. There seems, indeed, to have been intercourse of a somewhat intimate nature between the Babylonians and the Egyptians, even in prehistoric times, so much so that at least one Egyptian word—that for "year," *ronpet*—was regarded as a rebus, rendered "name (of) heaven," and gave birth to the barbarous Babylonian compound, *mu anna*, "name (of) heaven," which is the group used for *sattu*, meaning "year." This implies a sufficient knowledge of Egyptian, on the part of a Babylonian, to decompose and translate correctly the separated syllables of an Egyptian word, probably some thousands of years before Christ, when Babylonian was the *lingua franca* of the whole district between the Euphrates and the Mediterranean.

DIGESTION IN PLANTS.

By J. Pentland-Smith, M.A., B.Sc.

THE term digestion implies those processes by which food material is rendered available for the nourishment of the organism. We shall confine our attention in this paper to a consideration of some of the more remarkable cases of plant digestion.

The nutrient matter partaken of by the higher animals, such as man, undergoes various complex changes before it can be taken into the circulation, and definite changes occur in definite regions of the alimentary canal. To begin with, the food is masticated in the mouth, where it is at the same time bathed in a secretion poured forth by the salivary glands. Not only does this fluid enable it to pass more easily down the œsophagus or gullet into the stomach, but it digests certain of its constituents. The saliva contains a substance of complex composition, probably closely related to a class of chemical compounds termed proteids. One of the essential distinctions of proteids is that they consist of carbon, hydrogen, oxygen, nitrogen, and sulphur, united in percentage proportions somewhat as follows:—Oxygen, 20·9; hydrogen, 6·9; nitrogen, 15·2; carbon, 51·5; sulphur, 0·3. Many of them are constituents of food, and we shall have to speak presently of the changes they undergo preparatory to absorption. The proteid-like substance in the saliva, to which we now refer, is called ptyalin. Owing to its action the starchy portions of the food are converted into sugar. The curious feature is that the ptyalin itself remains unchanged. There are numerous examples of analogous actions in the domain of chemistry, and they play an important part in plant nutrition.

A substance like ptyalin, capable of causing chemical changes in other bodies while it itself remains unchanged, is called a *ferment* or *enzyme*.

When the food reaches the stomach it is subjected to the action of a fluid secreted by special cells lining its cavity. Some of these secrete an acid—hydrochloric acid—and others secrete a ferment called pepsin. The latter is only produced after the absorption of nitrogenous matter by the cells ; its function is the conversion of insoluble proteids into soluble compounds termed peptones.

It may happen that all the food material has not been rendered available for the animal's nourishment by the time it leaves the stomach. We find that there is a provision made to meet this contingency, for into the commencement of the intestine fluids are poured, which are secreted by the liver and pancreas. The bile, secreted by the liver, contains a ferment that converts starch into sugar, and the pancreatic juice contains three ferments: *trypsin*, which converts proteids into peptones—the action of pepsin—but which possesses the additional property of carrying the decomposition a stage further, breaking up

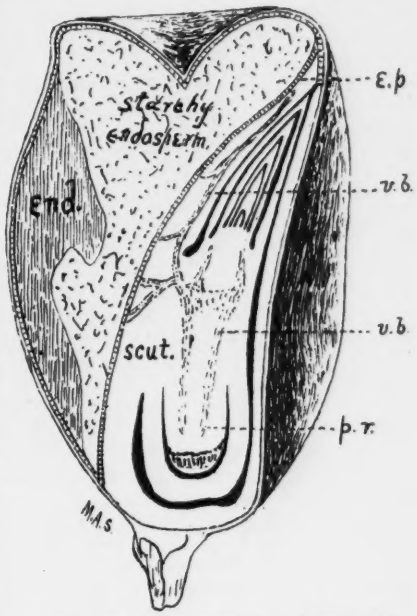


Fig. 1.—Longitudinal Section of Maize *(Zea Mais)* Fruit. *end.*, yellow dense portion of endosperm; *ep.*, epithelium of scutellum; *v.b.*, vascular bundles; *p.r.*, primary root.

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the peptones into "nitrogenous crystalline bodies, chiefly amides, such as leucin and tyrosin"; *steapsin*, which emulsifies fats, and then splits them up into glycerine and fatty acids; and *amylopsin*, by whose action starch is converted into sugar.

Now, it will be our endeavour to show that all these ferments have their representatives in the plant-kingdom, and to show what uses they subserve there.

In the foregoing figure (Fig. 1) we have a section of the maize fruit, cut so as to show the connection of the nourishing matter, or endosperm, with the embryo-plant. The endosperm is markedly divisible into two portions; that to the left, shaded darkly, consists of cells filled with nitrogenous material, the cells of the lighter shaded part adjoining the embryo being densely filled with starch. Starch is insoluble in water, and so cannot diffuse through the cell-walls. It is found that during the formation of the endosperm a ferment is formed whose function appears to be the conversion of starch into a substance that can easily pass through the cell-walls, and so be directly available as food for the growing embryo. This ferment has received the name of diastase. It converts starch into sugar. But diastase is not confined to the seeds of certain plants. It is of very common occurrence in the vegetable world. Indeed, one observer has asserted that it is present in all living plant cells. We may take as an instance the potato-tuber and show its use there. During summer the chlorophyll-bearing cells of the potato-plant manufacture a large quantity of sugar, much more than is required for its own growth. The superfluous sugar is carried down to the underground stem and is there stored in the form of the non-diffusible starch in portions of the stem, which in consequence become much swollen, forming the potato-tubers. These remain dormant during winter, but burst into vitality the following spring. Each eye, which is in reality a bud, shoots out into a stem bearing leaves, even although the tuber be kept in a dark cellar, and one observes that at the same time the tuber decreases in size and ultimately becomes quite shrivelled up. The development of the stem thus takes place at the expense of the tuber; it is accompanied by complex chemical changes, one of which is the conversion of the starch in the tuber into sugar by the agency of the diastase stored up there. The sugar thus formed helps to build up the protoplasm of the growing aërial stem.

Numerous other instances might be cited of the presence of this ferment in plant cells. In fact, its common occurrence has led to the classification of ferments having a similar action as diastatic ferments. It is obvious that the ptyalin of the saliva is one of these.

The action of diastase upon starch can be demonstrated in the following manner. The diastase is extracted from the seed by means of water and glycerine, and poured into a "solution" of starch. After a longer or shorter period —depending upon the temperature—the starch is seen to be converted into sugar. If its action be examined *in situ* it is noticeable that the grains are gradually dissolved in a uniform manner.

It has recently been shown by Brown and Morris that in addition to the diastase, whose almost universal presence in living plant cells we have just noted, there exists in the seeds of certain grasses another form of diastase, to which they have given the name of "secretion diastase" to distinguish it from the former, called by them "translocation diastase." Referring to Fig. 1, we see that a portion of the stem below the first leaf (cotyledon) is very large and shield-shaped. On this account it has received the name of scutellum. In its outer layer of cells, or epithelium, adjoining the endosperm, the secretion diastase is manufactured, and it is poured forth into the neighbouring endosperm cells, where its presence can be detected by its remarkable action upon the starch grains. It converts these into sugar, but their dissolution does not proceed uniformly; instead, the grains assume a markedly pitted appearance, and ultimately dissolve. This diastase also differs from translocation diastase in the time of its appearance. It is only formed when the grain commences to germinate. Its function thus appears to be the conversion of starch into sugar for the benefit of the germinating plant. If the actively growing embryo (Fig. 2, A) be placed on starch paste, with the scutellum resting on

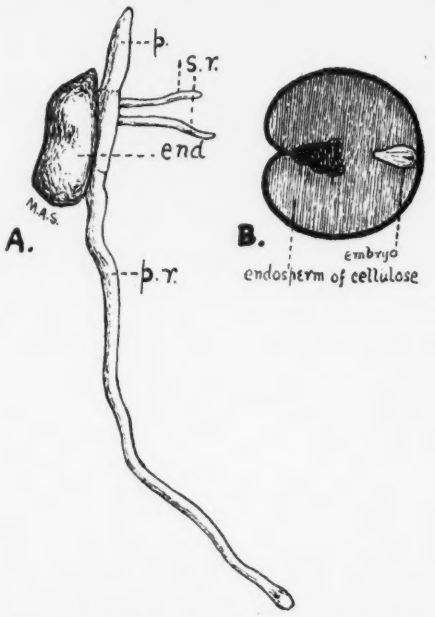

FIG. 2.—A. Germinating embryo of Maize, detached from endosperm; *end.*, scutellum; *s.r.*, secondary roots; *p.*, primary stem; *p.r.*, primary root. B. Transverse section of Date seed ("stone").

the paste, the starch grains will display marks of corrosion, due to contact of the secretion diastase secreted by its epithelium.

Yet another digestive action occurs in the endosperm of grasses, according to Brown and Morris. Previous to the dissolution of their starchy contents the cellulose cell walls near the scutellum become soft and ultimately disorganized. This is accompanied with the appearance of starch in the epithelial secreting cells. The diffusible substance formed from the cellulose is not known. Probably it is sugar, which, passing into these cells, becomes stored up as starch. The ferment causing this action has been isolated; it is a proteid substance, and is secreted by the epithelial cells of the scutellum. These cells thus secrete two ferments, one to dissolve the cell walls of the endosperm, and another to dissolve the starch grains thus exposed.

There are certain seeds in which the endosperm is composed mainly of cellulose. This is markedly the case in the date palm (*Phœnix dactylifera*). Everyone is familiar with the extremely hard nature of the date "stone." This stone is the seed of the date. A transverse section of it is shown in Fig. 2, B. The embryo occupies only a small portion of the seed; the remainder is filled with endosperm which has taken the form of cellulose. An examination of the seed a short period after

the commencement of germination shows a somewhat different state of affairs. The main part of the embryo lives outside the seed-coat; the endosperm has decreased in amount, and a part of the cotyledon is closely applied to it. As the embryo increases in size, the endosperm gradually decreases, until it finally disappears. From the relative positions of the parts it is obvious that it must have been absorbed by the young plant, and the only way to account for the corrosive action of delicate cells on so hard a material is the assumption that these cells secrete a ferment, and that this dissolves the cellulose, as in the barley grain. Search for such a substance in the date palm has, however, hitherto been in vain.

Prof. Marshall Ward, in an elaborate paper in the "Annals of Botany," shows that he succeeded in isolating a cellulose-dissolving ferment from a fungus called "batrytis," that sometimes causes havoc among lily plants, giving rise to what is known as the lily disease. The threads (hyphæ) of this fungus eat their way into the interior of the living cells of the host plant. From their tips a brilliant, refringent, viscid fluid is secreted. Marshall Ward cultivated the fungus in Pasteur's solution—a nourishing fluid containing the constituents of fungus food in a readily available form—and so procured a large number of the fungal hyphæ. On squeezing these in water he obtained a large quantity of a fluid containing the ferment in solution, for when it was applied to thin sections of the lily stem, the cellulose walls were observed to swell up and become gradually dissolved.

Starch and cellulose are composed of carbon, hydrogen, and oxygen, the latter two being present in the same proportion as in water, viz., one to eight by weight. Such substances are termed carbo-hydrates.

Hitherto we have considered only the digestion of these bodies; we shall now direct our attention to enzymes, by whose action complex nitrogenous compounds are rendered directly suitable for plant food. The most remarkable, or at least the most interesting, examples are found amongst the so-called insectivorous plants.

The pretty little Sundew (*Drosera rotundifolia*), consisting of a small root and rosette of reddish-green leaves, nestling in tufts of sphagnum moss, displays a markedly digestive action, causing it to resemble the animal stomach in many respects. Its method of capturing and retaining its insect prey was explained in a previous paper in Knowledge. In it, as in other insectivorous plants, the use subserved by its digestive property is quite obvious from a consideration of its habitat. It lives in marshy places, where there is small store of nitrogenous food. The species of Drosera shown in the plate (*Drosera dichotoma*) is not a British fern, but it illustrates the main features of the British species. Insects retained by the viscid fluid secreted by the leaves soon undergo decomposition. The nitrogenous parts of the body are digested—the hard outer skeleton alone is left—and the products of digestion are absorbed by the leaves. After stimulation by the absorption of nitrogenous matter, the secreted fluid contains a ferment and an acid. The ferment in presence of the acid attacks proteids and converts them into peptones. The stomach, we previously noted, contains an acid, and a ferment called pepsin, which has the same property as that of Drosera. Pepsin also is only secreted after the absorption of nitrogenous matter by the walls of the stomach. In these respects, then, it appears that the digestion occurring on the tentacles of Drosera is similar to that taking place in our stomachs. It would appear that the ferment of Drosera is the same as, or at least closely allied to, the pepsin found there.

The leaves of *Pinguicula vulgaris* (the Butterwort), another common British insectivorous plant, displays a like action to that of Drosera. Insects captured by the sticky secretion on the upper surface of the leaf are rolled towards the centre by the incurving margin, which secretes a peptic fluid.

A photograph of Venus's Fly-trap (*Dionæa muscipula*), a native of North Carolina, is reproduced in the accompanying illustration. On each lobe of the leaf are three long jointed hairs, extremely sensitive to contact of a solid body.

Venus's Fly-Trap.

An insect alighting thereon and touching one of the hairs instantly finds itself a prisoner, as the lobes immediately close up and clasp tightly the unwilling guest. Glands on the upper surface of the leaf secrete an acid fluid, into which a ferment is poured after the absorption of nitrogenous food. The result is that the captured insect is soon digested, with the exception of the hard cuticular skeleton. The glands are shown in section in Fig. 3, B. They consist of a rosette of cells supported on a very short stalk, bringing them slightly above the level of the other epidermal cells. The section also illustrates the jointed nature of the long hairs. The presence of the joint enables the hair to bend down, and thus prevents it breaking when the lobes become approximated.

The arrangements for the capture and retention of insects with a view to digestion are very elaborate in the Nepenthes or pitcher plant, a specimen of which is shown in the plate. The winged portion of the leaf (the petiole or leaf-stalk), the tendril, the outer surface of the pitcher,

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and the under surface of the lid are covered with nectar-secreting glands. Especially numerous are these on the under surface of the winged petiole. They allure insects to the orifice of the pitcher. The rim is corrugated, and each corrugation corresponds to a bottle-shaped nectar-gland, whose orifice faces the bottom of the pitcher. The

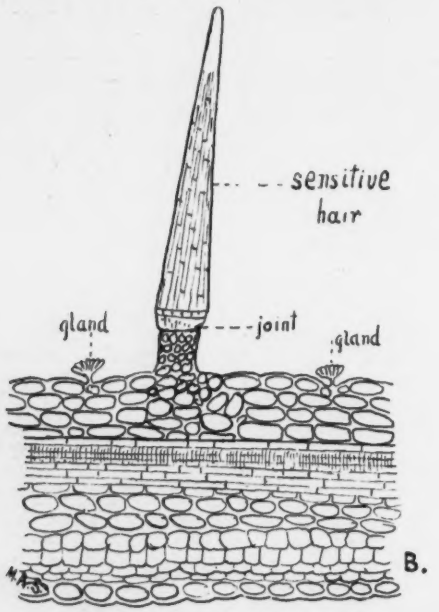

Fig. 3.—B. Transverse section of leaf-blade of *Dionæa muscipula*. Notice the jointed sensitive hair and the digestive glands.

upper part of the inner surface is so very smooth that an insect is unable to obtain a foothold thereon; the lower part is partly filled with a watery liquid, into which is poured a digestive fluid by peptic glands lining that portion of the inner surface. The upper smooth part has been termed the conducting surface. In the sketch on the following page (Fig. 4, A) is depicted a small portion of it. The lenticular excrescences were considered by the late Prof. Dickson to be modified stomata; Prof. Macfarlane has lately verified this supposition by finding every transition between these and perfectly formed stomata. What happens is this: one of the stomatic guard cells rises above the level of the epidermis in such a manner as to cover the other guard cell and the stoma from the view of the observer. The function of these modified stomata is unknown, but it is conjectured that they secrete the greater part of the liquid found in the cavity of the pitcher. In support of this it is to be noted that the pitcher lid is at first closely applied to the rim of the pitcher; by and by it gradually opens, and never again shuts up. But in unopened pitchers a considerable quantity of liquid is to be found, and Macfarlane states that in species of Nepenthes, with a large conducting area, large quantities of liquid are exuded. In any case the liquid, containing an acid and a ferment, acts in a manner quite similar to the digestive action of Drosera, with the result that in the pitcher insects may be found in all stages of decomposition. This decaying mass must act as an attraction to insects in the native haunts of the Nepenthes, causing them to fly straight into the cavity of the pitcher.

Macfarlane gives an interesting account* of observations made by him on the visits of insects to the Nepenthes in the conservatories of the Royal Botanic Gardens, Edinburgh:—"Being in (one of the conservatories) at 8·30 p.m. on a clear evening in June, a large cockroach was noticed to be perched on the front part of the corrugated collar of a fine pitcher of *N. khacyana*. Approaching cautiously, it was seen to bend its head into the pitcher cavity and sweep it rapidly in successive jerks round the inner edge of the corrugated collar, where the products of the marginal glands would lie. Sipping the material from these, it then rested for a moment, and enjoyed with evident relish the cleaning of what adhered to its mandibles. It then repeatedly tried with its fore legs to step on to the conducting surface of the pitcher cavity, but always slipped; so leaving this it reared itself on its long hind legs by planting one on each side of the rim, catching with the middle legs on to the lower sides of the lid. Placing its fore legs on the middle of the lid, it swept with its mouth parts the richly honeyed surface in long lines. But this did not appear to be satisfying, when compared with the product of the marginal glands, for it speedily returned to these and renewed its jerking mode of feeding. It again attempted to get into the pitcher cavity, but finding this unsafe, it finally licked up traces of the marginal gland-secretion which its fore feet had smeared on the corrugated collar. Running down the outside of the pitcher, it passed up the tendril and on to the under laminar surface, where its presence would have been perfectly unsuspected had any insectivorous birds been in the neighbourhood, and where also, as Mr. Symington Grieve has suggested, it would have been sheltered from the sun's heat in the daytime. I gently scratched the upper surface above where it was, and it at once retraced its steps in a hurried manner, till it reached the outer surface of the pitcher. Here it rested for a time sipping the juice which exuded from alluring glands, but it soon passed to its old position on the collar. Though disturbed a few minutes before, it seemed quite to forget its fright, and again fell to cleaning the marginal gland-orifices with the utmost care and gusto. It rested now and again only to resume operations, once making a short excursion to the lid-surface, which appeared to me to offer far greater attraction, but seemingly regarding this as inferior, it returned to the collar. Constantly trying to get on to the conducting surface, and as often foiled, it again ran up along the tendril to the under surface of the lamina. Again I scratched this, and the former course was taken, the former efforts made. I was greatly struck by the careful way in which, while attempting to pass into the pitcher, it hooked its two strong hind legs over the reflexed collar-margin, and by the ability it showed to pull itself back by these alone, the second as well as the first pair of legs often being inside the pitcher. Tired of its movements after the fifth excursion, and finding that twilight was approaching, I finally jerked it into the cavity with my pencil, as it hung on the ridge exploring the interior. In its fall it quickly spread out its long legs against the sides of the conducting surface, and struggled violently to get out. For a short time this proved useless—it rather slipped deeper; but after one severe effort it hooked the claws of its fore legs over the corrugated rim, and pulled itself out. I considered that it had fairly earned liberty, and it speedily moved off."

This observation confirmed the supposition of the great attractive nature of the marginal glands of the corrugated rim. Observations on the visits of ants afforded further

* "Annals of Botany," Vol. VII., page 436.

THE PITCHER-PLANT.

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confirmation. These insects are allured by the glands on the stem and leaf to the margin of the pitcher, proceeding by way of the under surface of the winged petiole, on whose ridge are numerous nectar-secreting glands. The wings also shield them from the rays of the sun and from the observation of foes. Having reached the pitcher rim they strive to obtain nectar from the orifices of the marginal glands, and in their eagerness they over-reach themselves and fall into the cavity of the pitcher, from which escape is practically impossible.

In connection with the visits of ants to Nepenthes, an extremely interesting circumstance has been noted which seems to throw some light on the doctrine of acquired characters—a point of dispute amongst biologists. *Nepenthes bicalcarata* is infested by a particular species of ant. On the tendril opposite the bottom of the pitcher is a small swelling. In specimens obtained from its native habitat a round hole has, as a rule, been drilled in the swollen portion; but in those grown in our conservatories, although the swelling is always present, it is never punctured. The suggestion has been made that the ants, finding it impossible to obtain the liquid contents of the pitcher in the ordinary way without fatal issue to themselves, have resorted to this method from an instinctive knowledge of the fact that water will rise to its own level, for when the swelling is punctured the liquid in the pitcher oozes from cell to cell until it reaches the aperture. The extra supply of liquid thus brought to this region of the tendril causes an excessive growth of the tissues at this point. Owing to the visits of these ants, this hypertrophy has occurred in the majority of individuals of the species for numberless successive generations, and has so affected the constitution of the plant that now the swelling always appears, although the original inducing cause be absent.

In the accompanying plate a specimen of the Australian Pitcher plant *(Cephalotus follicularis)* is shown. It is only found in the moorlands of Albany, in Western Australia. Two kind of leaves are found on the plant. The laminæ of the lower rosette of leaves are transformed into pitchers to entrap unwary insects. The pitchers are rendered attractive by their bright colour, and their outer surface is provided with nectar-secreting glands. As the pitchers rest on the ground, wingless insects are thus allured into their cavities. Once inside, escape is almost impossible, as a consideration of the structure of the interior of a pitcher will render evident. On the inner edge of the involute margin is a fringe of decurved spines, and every cell of the epidermis below is projected into a sharp downward-directed hair. The rim of the deep circular involution is likewise armed. Then the basal portion of the pitcher is filled with a liquid, into which are exuded an acid and a ferment by glands situated on that portion of the epidermis.

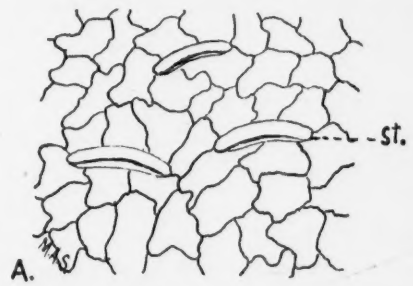

FIG. 4.—A. Portion of epidermis from conducting surface of pitcher of Nepenthes. Notice the lenticular excrescences *(st.)*. These are modified stomata.

The trypsin secreted by the pancreas has its analogue in the plant kingdom in a ferment found in a tropical plant called the Papan *(Carica papaya)*. Green states that the natives of India have for long used the fruit of this plant for cooking with tough meat to make it tender, and that there is a prevalent notion that wrapping its leaves around it, or even hanging it under the tree, has a similar effect! Certain it is that a ferment—papäin—has been isolated from the fruits, which has the power of digesting various proteid substances.

The power of the walls of the true stomach of the sucking calf—rennet—to coagulate milk by the secretion of a ferment is familiar to all; but some plants have a similar property. The common Bedstraw (*Galium verum*) is even now used by West of England dairymen for this purpose, and in the days of Linnæus the Laplanders put the leaves of *Pinguicula vulgaris* (the Butterwort) to the same use. Both plants contain a milk-curdling ferment, which has also been found in the stem, leaves, and seeds of various other plants.

In *Ricinus communis* (the Castor-Oil plant) the endosperm is oily. If a glycerine extract of the germinating seed be mixed with an emulsion of castor-oil, and kept at a temperature of 40° C., the liquid becomes acid, and after some days glycerine make its appearance. If the extract be boiled before it is added to the oil, these changes do not occur. They are the result of the action of a ferment present in the endosperm of the germinating seed. This ferment is thus similar in its action to the steapsin of the pancreas.

ANTIVENINE.

By Dr. J. G. MCPHERSON, F.R.S.E.

IN the July number of KNOWLEDGE I communicated some of the results of Prof. Fraser's admirable experiments on snake poisons and their antidote. The other day he laid before the Royal Society of Edinburgh some equally important results. He has continued the same line of experiment with increased success, and he can now see the very important boon his discovery will confer on the people of India.

His method is to ascertain the minimum lethal dose for an animal; to begin experimenting upon a similar animal with a smaller dose. After a short interval he increases this dose, until in time he can inject fifty times the minimum lethal dose into the animal's blood without producing any bad effects. This animal is immunized, and its blood serum, injected into another animal of the same size and weight, will prevent the action of snake poison when injected. Besides, if, in an animal which has had snake poison injected into its blood, a quantity of this immunized blood serum be injected within a reasonable time, the poison is antagonized, and is rendered innocuous. This immunized blood serum is called by its discoverer *antivenine*.

Prof. Fraser has now found that the blood serum of a rabbit, which had received thirty times the minimum lethal dose, was quite as effective in its antitoxic properties as that of a rabbit which had received fifty times the minimum lethal dose. The latter, however, will survive a much larger dose than the former. Still, for antivenine purposes, this is a saving in the very scarce snake poison.

The most important discovery was to be left for the experiments on the horse. So much poison was required to immunize a horse, that the professor had to defer his experiments until he procured from the Indian Government a sufficient quantity. This he has secured. In

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February he commenced injecting a clean horse with one-fifth of the minimum lethal dose. The next injection of one half the minimum lethal dose was given seven days later; then three-fourths of that quantity five days after this. He went on gradually increasing the dose in this way for four months and a half. The first injection caused general disturbance and rise of temperature, but the subsequent ones had no bad effect, except the local symptoms of cutaneous œdema and necrosis of small patches of skin at the point of injection. He obtained the blood serum from this immunized horse, after the long interval of experiments, by drawing off some from its jugular vein. He found that a hundredth and even a thousandth part of a cubic centimètre per kilogramme of animal was sufficient to prevent death from the minimum lethal dose of the venom. The antivenine obtained from the horse was found to be twice as powerful as that from the rabbit. The dose last given to the horse may have been fifteen times the minimum lethal dose, so that antivenine can evidently be obtained from the horse by administering that quantity of the poison. Although experiments may yet prove that more powerful antivenine might be desired, yet that obtained from the horse is quite powerful enough for counteracting the poison of snake-bites in man.

Already a quantity of this antivenine is on its way to India for use there. Prof. Fraser has put it up in two forms, a liquid and a dry form. The dry state has an advantage over the other in more ways than one—it goes into less bulk, is practically indecomposable, and loses none of its antitoxic properties by being dried. On the other hand, some which was put up in the liquid form underwent decomposition, or at least, became quite turbid in appearance, though at first quite clear. Now if that happens in our temperate climate, it would be much more likely to decompose in tropical countries. Accordingly the dry antivenine will ultimately be the exported product for use in India.

Prof. Fraser has observed a peculiar fact, viz., that dietary has an effect upon venom poisoning: for example, if an herbivorous animal be put upon flesh diet, the effect of venom upon it is much lessened. To prove this, he took a family of young white rats, and for seven weeks fed them entirely upon flesh food, except occasionally when a little vegetable food was given to keep them in good health. One of these rats had an injection of one and a half times the minimum lethal dose to commence with, and there was very little or no change produced by the poison. Another had twice the minimum lethal dose injected; it recovered after a short illness. The other rats died from ill-health occasioned by the change of dietary.

By another set of experiments, Prof. Fraser has found that the deadly effects of serpent's venom is supposed to be due to its effect on the blood. Venom is almost inert when introduced into the stomach or any other part of the alimentary canal. A cat was made to swallow one-fifth of the minimum lethal dose, then one-third, and then one-half, and so on, until on the one hundred and sixteenth day it received into the stomach at one time a dose eighty times larger than what would have killed a clean cat by injection—yet no observable disturbance was produced by these doses. To have carried these experiments any further would have required upwards of a gramme of venom. This he could not afford with a rapidly diminishing supply. This cat, so far immunized by the stomach, was then given under the skin an injection of one and a half times the minimum lethal dose; and no bad effects were produced except the merely local ones. In the curious case of a cat which was being immunized while pregnant, it was found that the kittens, after birth, also became immunized through the mother's milk. One of the kittens received a dose considerably above the minimum lethal dose and recovered.

Important evidence in favour of the administration of the venom into the animal's stomach, for the sake of having it immunized, has been obtained with white rats. One received by the stomach a thousand times the amount which would have been a minimum lethal dose when injected under the skin into the blood. Afterwards, the same rat had twice the minimum lethal dose injected subcutaneously, and it became sleepy for a time, but soon recovered its hilarity. Accordingly, when snake's venom is introduced into the stomach it does not produce any active poisoning effects; but some of it seems to become absorbed into the animal's blood so as to assist in the immunization. This may account for the immunity from snake-bites said to be enjoyed by some of the snake-charmers of India, who eat the dried poison glands of the snakes.

Snakes themselves seem to have some substance in their blood which renders them impervious to the effects of the poison. This may probably be got from venom shed from the poison-glands, and absorbed through the mucous surfaces of the mouth; or it may be absorbed by the blood-vessels and lymphatics passing to and from the glands. In some cases it may be secured by serpents devouring other members of their tribe, thereby absorbing venom by the stomach.

Prof. Fraser has obtained a living venomous snake, and he intends to test its blood for antivenine; but as it has been shedding its skin since he received it, he has put off the experiments till the animal recovers its good health.

It is now within the region of certainty that at no distant date this indefatigable snake-charmer of a scientific character will be able to send out to India sufficient quantities of dried antivenine from the immunized horse to be of inestimable service to those who are exposed to the bites of venomous snakes in that extensive country. The experiments, interesting and curious as they undoubtedly are to the ordinary reader, are of paramount importance to humanity; and Prof. Fraser's discovery is sufficient to give him a distinguished place among the advancers of medical research. Should he yet be able to discover the chemical constituents of the antivenine so as to manufacture it by chemicals, his success will be complete. All interested in the saving of life must wish him every success in his laudable undertaking.

LEAPING BEETLES.

By E. A. Butler, B.A., B.Sc.

THE power of springing up into the air, and thus taking long leaps from place to place, is not a very prevalent accomplishment in the insect world, and amongst British insects it is possessed by not more than about four per cent. of all the species. Besides occasional instances here and there, such as the fleas and the cheese-jumper, in the order Diptera, there are certain groups of greater or less extent that are distinctly characterized by the habit. The best known of these are no doubt the grasshoppers amongst the Orthoptera, the frog-hoppers amongst the Homoptera, and the spring-tails, which constitute the order Collembola, minute, soft-bodied creatures, found in great abundance in grassy places, and under stones, logs of wood, dead leaves, moss, etc. The gymnastic mechanism in both the spring-

tails and the familiar cheese-jumper is of a somewhat exceptional character; the former have a forked spring bent under their bodies, and the latter performs its spasmodic jerks by coiling itself into a circle and then violently straightening itself out, with the result that it is shot about indiscriminately in a manner that defies calculation. But in most of the other instances the mechanism is of one uniform type, and consists of a highly developed mass of muscles enclosed within the greatly enlarged thighs of the hind pair of legs, and this may be considered as the most usual type of structure associated with leaping habits, finding its counterpart even amongst vertebrates in the enlarged hind legs of the kangaroos and jerboas.

This type of structure is exemplified, not only in the familiar groups already enumerated, but also in another set of leapers, less well known, and found amongst the Coleoptera, or beetles. These leaping beetles form the group known as Halticæ, and it is this group of which we are to speak in this paper. They are almost all of very minute size, and consequently not generally well known; nevertheless, many of them are extremely abundant, and from their ravages, some of them have become of considerable commercial importance. The best known and the worst offenders are called by farmers "turnip fleas," or "turnip flies," and as an example of the havoc it is possible for them to work, Curtis, in his "Farm Insects," mentions a case reported from Devonshire in 1786, in which it was stated that damage to the extent of £100,000 was done to the turnip crop during an unusual visitation, in that county alone. This group of leapers forms a homogeneous collection of vegetable feeders, amounting in the British Islands alone to some hundred and twenty species, which is not more than one-third of the number that inhabit Europe at large. But as the majority of them are attached to wild plants which are of no commercial importance, the true pests form but a small percentage of the total number of species.

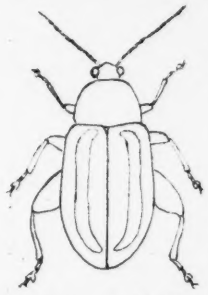

Fig. 1.—Turnip Flea (*Phyllotreta nemorum*); magnified twelve diameters.

The strong family likeness that exists amongst all these beetles makes it easy to obtain a good idea of the general structure and habits of the group from the detailed examination of a single species. We will select as our typical example one of the commonest of the group, the "turnip flea," properly so called. It is a minute, hard-skinned beetle, ranging from about one-twelfth to one-tenth of an inch in length, with black body, bronze-black thorax, and black wing-covers, each of which is adorned with a longitudinal yellow stripe, and covers a large folded membranous wing. This description, however, is not nearly minute enough to correctly distinguish the species, for it would apply equally well to several species which are very closely allied, and differ from one another chiefly in such minute points as the width and exact shape of the yellow stripe, and the colour of the legs. The true turnip flea is called *Phyllotreta nemorum* (Fig. 1), but in all probability its depredations are considerably exceeded by those of a far commoner and slightly smaller species, called *P. undulata*, which is one of the most abundant insects in the country. These two little pests and their allies belonging to the same genus are specially attached to cruciferous plants, notably the turnip, radish and horse-radish amongst cultivated kinds. To anyone who has grown a bed of radishes it must have been a familiar experience to note the leaves riddled with multitudes of minute holes (Fig. 2), as though they had received a charge of small shot. This damage is the work of turnip fleas. If a bed of radishes so marked be carefully looked over, especially if the holes appear freshly formed, the eye will soon learn to detect a number of minute insects here and there, sitting on the leaves; as soon as the hand approaches them with intent to capture, they suddenly pass into invisibility by springing up so quickly that the eye cannot follow the direction they take, just as would be the case with a true flea.

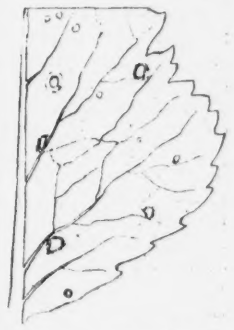

Fig. 2.—Portion of Radish Leaf perforated by Turnip Flea.

The oval green eggs are laid on the under side of the leaves, but as the perfect insect itself is, at the outside, no more than one-tenth of an inch in length, it is easy to see that the eggs must be so minute that a search for them over the wide area of a turnip field would be rather a hopeless matter. The best way to observe them is to place some of the beetles in a glass tube surrounding a growing plant in a flower-pot; they will soon lay some eggs, and a lens brought to bear upon the few leaves enclosed will be able to discover them. The eggs hatch in about ten days, yielding a little six, or rather, seven-legged caterpillar-like being, which at once eats its way into the body of the leaf; ensconced there, it proceeds to devour the soft cells of the leaf tissue that lie between the two cuticles, thus excavating a minute tunnel, along which it travels by means of its six hook-like front legs and its terminal prop.

Fig. 3.—Chrysalis of Turnip Flea.

It takes rather less than a week over this operation, and then leaving its burrow, descends to the ground and buries itself in the soil to the depth of one or two inches, taking care to select a spot near to the turnip root, so that the overhanging leaves may provide suitable shade and preserve a proper amount of moisture in the soil. While thus buried it becomes a chrysalis (Fig. 3), which, small as it is, exhibits all the details of the future beetle, head, thorax, wing-covers, legs, antennæ, neatly folded beneath the investing pellicle.

About a fortnight is sufficient for the necessary internal changes to be completed, and then the new beetle issues from its close-fitting garment and pushes its way to the surface of the soil, ready to resume the attack on the leaves which has for the past fortnight been intermitted, but attacking them from without instead of, as before, from within. Thus a period of rather less than five weeks suffices for the beetle to pass through all its changes, from the egg to the adult, though this must not be taken as a measure of its lifetime, for it often lives for several months after becoming a perfect beetle. So short a period being all that is necessary to carry the insect through its transformations, and put it into the position of becoming the founder of a family, it is not surprising to learn that several broods are to be met with during the course of one season. A succession of five broods is not an unusual number, and though the insect is not by any means what might be called a prolific pest when compared with most others, rarely laying more than one egg per day, still there are considerable possibilities of multiplication involved in this succession of broods. Large numbers of the insects survive the winter, going into winter quarters in moss,

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under the bark of trees, under stones, or in any other of the thousand and one hiding-places easily discoverable by an enterprising creature, gifted with a triple locomotive power, in walking, leaping and flying.

Considering the insignificant size of the beetles, and the really minute quantity of matter which, at the most extravagant computation, must be sufficient to serve them as provisions for a lifetime, it is difficult to realize the possibility of their becoming a serious nuisance to agriculturists; and, indeed, it is only under special conditions that their depredations are of much importance. When we have the plants at their weakest, and the beetles at their strongest, *i.e.*, when the plants are seedlings and the insects fully grown, it is then that the most serious results follow from the attack of the beetles. The mining of the full-grown leaves by the grubs is a matter of very little importance, and in fact can scarcely be detected till the grub has left its tunnel, when the cuticle forming its roof becomes dry and discoloured. But if the beetles happen to be in the perfect condition just when a young crop of turnips are appearing above ground, they will at once attack the cotyledons or seed-leaves, and speedily ruin the plant by weakening it and cutting off its supplies. But after the plant has reached a certain size, it has vitality enough to enable it to withstand the damage, which with the large size of the plant is, of course, proportionately less, and hence the attacks of the beetles are not of so much consequence.

If the insects confined themselves to cultivated plants, it would no doubt be easier to take measures against them; but this is not the case. They are found naturally on many wild cruciferous plants, such as charlock, hedge mustard, etc.; but if a crop of turnips springs up in the neighbourhood, they will not be long in discovering the fact, and speedily forsake their natural food for the more luxuriant supply man has provided. It seems likely that they are guided by scent, for they have been observed advancing in great numbers towards a newly-appearing turnip crop *against* the wind. In warm weather they readily take to the wing, but as the temperature falls they become less active. Their favourite method of locomotion is certainly leaping, and they can cover about eighteen inches at a single bound. As they are so abundant, so easily travel from place to place, and so readily find other foods when man's supply fails, it follows that a complete extermination from an infected field on a given occasion would not guarantee immunity from the pest a short time afterwards. However many we may destroy, there is always a plentiful residuum left amongst the grass and weeds in most uncultivated places, ready to swoop down upon the young crops as soon as they put in an appearance. It is curious that the jaws they use to nibble their holes in the leaves are, though a pair, unlike in shape; both are strongly toothed (Fig. 4), but one is furnished with three teeth and the other with four. Of course these jaws move laterally, and the pieces, as fast as nibbled off, are helped into the mouth by the rest of the mouth organs, viz., maxillæ and two pairs of palpi. If the head is severed from the body, and placed in a drop of water between two slips of glass under the microscope, a little pressure on the glass soon causes the jaws to open, when their shape can be seen.

Fig. 4.—Jaws of Turnip Flea.

Several very distinct types may be easily recognized amongst this group of leaping beetles; they contain also some of the most brilliant of our British insects, and several species, if they were only constructed on a larger scale, would easily carry off the palm for splendour. There is a set of brilliant purplish-blue species, constituting the genus *Haltica*, which are amongst the largest of the group. They are all very much alike, and the discrimination of the species is one of the most trying tests of the patience and acumen of the coleopterist. One of the best known occurs amongst heather, where the beetles are often to be met with in hundreds. Of course, a mere cursory glance will not detect them, but anyone who will take the trouble to sit down amongst the heather and patiently and minutely scrutinize the plants will soon learn to see the brilliant little gems, sitting about here and there, with their hind legs bent beneath them, ready for a spring the moment they are disturbed. Two or three others have shining blue wing-covers and a bright red thorax, a style of ornamentation that is by no means peculiar to this group. On various kinds of willows are to be found, often in swarms, the brilliant species of the genus *Crepidodera*, which exhibit a marvellous play of metallic colours of the most glowing tints—coppery, golden green, and the brightest emerald. They are noted also for the regular rows of minute pits, which modify the play of light, and give an added charm of aspect to the wing-covers. Certain species inhabit thistles, and these are generally of a reddish colour; some of them are extremely globose in form, and with this peculiarity of shape is usually associated an excessive degree of agility. Others prey upon various low plants, such as certain labiates, the rock-rose, woodspurge, mallows, docks, etc. One pretty little polished blue-black species skips about amongst the leaves of the dog-mercury, which it riddles with holes.

But one of the most remarkable features of the group is the curious structural freaks that are manifested in the hind legs, in addition to the swelling of the thighs. One genus (*Plectroscelis*) is distinguished by having a tooth-like projection on the outer side of the tibia, or shank, about halfway down (Fig. 5, A). A very abundant species (*P. concinna*), which is entirely of a bronze colour above, has, by its attacks on hops and turnips, achieved sufficient notoriety to be dignified with more or less appropriate

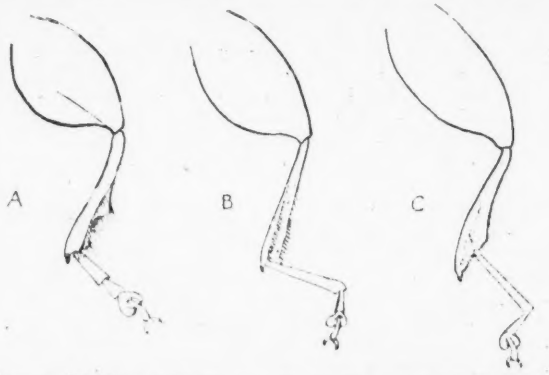


Fig. 5.—Hind leg of (A) *Plectroscelis*, (B) *Thyamis*, (C) *Psylliodes*.

popular names, such as "hop flea," "brassy turnip flea," "tooth-legged turnip beetle." A peculiarity of a different sort is to be seen in the genus *Thyamis* or *Longitarsus*. This genus comprises an extensive set of small beetles, which are mostly of a pale yellowish, or yellowish-brown colour, and therefore of no great beauty—what one may call a homely and serviceable, rather than an ornamental type of insect. The tarsus, as usual, consists of apparently four, but in reality five joints; but the basal one is extraordinarily long, half as long, indeed, as the entire tibia or

preceding division of the leg (Fig. 5, B). This peculiarity alone gives the foot a strange appearance, reminding one of the curiously elongated ankle bones in the hind leg of the frog; but this is not all, the second joint is attached to its predecessor in an entirely exceptional way. As a rule, the various joints of an insect's foot, numbering from two to five, move but slightly upon one another at their hinges, a little motion on the part of each joint thus causing the whole foot to assume a regular curve. But in these little beetles the second division of the foot is attached to the first by a socket joint, which gives far greater freedom of motion, and one may often see the outer half of the foot bent at right angles to the rest and seeming as if it were dislocated.

But the most astonishing peculiarity of all is that which characterizes the hind legs of the genus *Psylliodes* (Fig. 5, C), a set of robust, long oval insects, one of which is destructive to hops. The tarsus of the hind leg has the same elongated basal joint as *Thyamis*, and the same tendency to bend the outer part at right angles to the rest; but it adds to these the further peculiarity that the foot is not attached to the apex of the tibia (as is almost universally the case, not only amongst beetles, but also amongst insects of other kinds), but is inserted on the outer side some little distance before the apex, so that the end of the tibia projects considerably beyond it, thus giving the leg an awkward and, indeed, malformed appearance. The muscles which move the foot have a great tendency to contract suddenly, and cause the foot to spring back against the leg in a way which reminds one of the elevation of a drawbridge, and is very provocative of irritation and impatience on the part of the collector who wishes to set his specimens neatly. No doubt these various oddities of structure in the tibiæ and tarsi are connected with the bending of the legs under the body for the purpose of leaping; but as they are not universal in the group, they can scarcely be essential to the habit. For example, the notch on the hind leg of *Plectroscelis* is also found on its intermediate legs, which are not bent under the body, nor used in leaping. It is also found on the hind legs of other plant-eating beetles, which have no power of leaping at all. Altogether, therefore, it is not easy to see what is the exact explanation of the presence and variety of these irregularities in the hind legs of leaping beetles.

ON THE DISTANCE OF THE STARS IN THE MILKY WAY.

By C. Easton.

THE perfecting of celestial photography, due to the patient and ingenious efforts of Messrs. Henry, Roberts, Wolf, Barnard, Russell and others, is rightly considered the chief glory of modern astronomy. Thanks to the late Mr. A. Cowper Ranyard, the readers of Knowledge have always had the first-fruits of the results obtained by these savants, and numerous photographs, in particular of the Milky Way, have been reproduced for their benefit in this magazine.

These photographs of the Milky Way often show extremely interesting details. I need only mention here the *nebulosities*, which in many cases are certainly real;* the curious arrangement of the stars in *ellipses*, which in many cases it is impossible to attribute to an effect of chance;† the "Triple Nebula," described by Dr. Max Wolf (*Astronomische Nachrichten*, No. 3214); the dark lanes to which Mr. Ranyard drew the attention of astronomers, and of which Mr. E. W. Maunder has given an explanation (Knowledge, February, 1895), which certainly appears to be plausible.

Nevertheless, the examination of these admirable photographs gives rise rather to hypotheses and reflections, than to conclusions of which the evidence is clear and striking. As long as we are unable to turn this evidence into actual numbers, there will always be some astronomers who will refuse to accept it—Proctor had some experience of this!—and in reality it is fortunate that it is so, as perhaps in no branch of astronomy is there so much danger of arriving at premature conclusions, as in investigations concerning the "Structure of the Heavens." Thus, on the one hand, the researches of Struve, Gould, Ristempart, Kapteyn, and others,‡ tend to the admission that relatively bright stars may be distributed fairly evenly around a small mass, of which our sun would form part; and, that by general consent the Milky Way, properly speaking, may be represented very nearly in the annular form. But on the other hand, the examination of photographs, as well as the careful study of the aspect of the Milky Way with the naked eye, will show that this hypothetical "ring" must possess an extremely complicated structure,

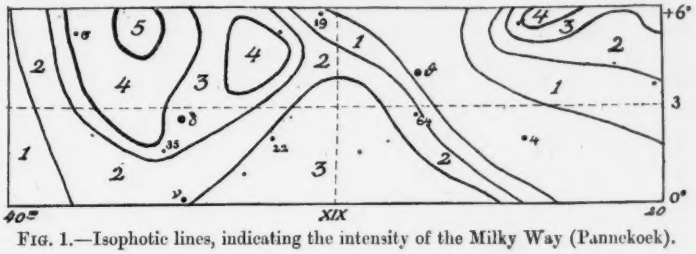


Fig. 1.—Isophotic lines, indicating the intensity of the Milky Way (Pannekoek).

and that it is composed of a large number of groups or stellar *strata*, where a certain process of agglomeration already appears to manifest itself, but which strata seem to superpose themselves in the direction of the visual ray.

There is nothing to indicate whether in general these groups are relatively near to each other, or whether they may be, on the other hand, marshalled at enormous distances one after the other in the direction of the line of sight, distances which, even when compared with the distance separating us from the nearest of these groups, may be tremendous. I hope that the researches of which the results are here given may throw a little light on this latter question.

The study of the distribution of the stars in space would have made a great stride if the apparent distribution of the stars of each separate order of brilliancy on the celestial sphere were known. Prof. Holden, after comparing the results of the star gauges one with another, says (*Publ. Washburn Obs.* II.): "If these differences m-n, n-o, etc.—between the numbers of stars belonging to each nominal magnitude m, n, etc., as shown by the gauges—be platted separately, the eye can determine whether each group is affected by a clustering power peculiar to itself, or whether the same cause is apparent in the configuration of

* See especially the photograph obtained by Dr. Isaac Roberts, of H.V. 15—"A Selection of Photographs, &c.," plate 45.

† Compare Holden, *Monthly Notices*, Vol. L.; Wesley—Knowledge, August, 1894; see in particular the photograph of the Cygni region—Knowledge, December, 1891.

‡ See article on the work of Prof. Kapteyn (Knowledge, June, 1893), and Mr. Gore's article in the January number, 1895.

the various groups. The question of how many nominal magnitudes correspond to stars which really belong to the same system and are at the same distance, appears to be capable of solution by this process, and other cognate questions will have some light thrown upon them."

To arrive at this result the simplest way would be to classify, on photographs which show the fourteenth to fifteenth magnitudes, all the stars according to their magnitudes, and to count the number belonging to each magnitude. But this would entail gigantic labour, and would be so difficult in practice, that there is no hope of seeing it carried out for the present. In the meantime I have attempted to compare, at any rate as regards some regions of the Milky Way, the connection between the result of star gauges and star countings, and the intensity of the general Galactic light.

As regards the regions that I am about to refer to, it can be safely assumed that in general the greater or less intensity of the Galactic light in a given district corresponds to the greater or less density of the fainter stars, those inferior to the ninth magnitude. (See for further particulars *Astronomische Nachrichten*, No. 3270.) Now, if we consider firstly the zone included between R.A. 18h. 20m. and 19h. 40m.; N. Decl. 0° to 6° (Aquila), it follows from the evidence of a comparison of the descriptions and drawings of the Milky Way by Heis, Trouvelot, Houzeau, Klein, Boeddicker, Gould, Easton and Pannekoek,* that if this region be divided into four equal parts, the part (A and B) included between R.A. 18h. 20m. and 19h. 0m.; N. Decl. 0° to 6°, is poorer in Galactic brightness than the opposite half (C and D) between R.A. 19h. 0m. and 19h. 40m.; N. Decl. 0° to 6°; whilst the contrast is greatest between A, where the Milky glimmer is the weakest, and D, where the Milky Way presents considerable intensity.

The number of stars of the first to 9·5 magnitudes can be ascertained from the "Bonn Durchmusterung" of Argelander for each of these four divisions and for each semi-order of brilliancy; the star counts by Celoria (*Pubbl. del Osserv. di Brera*, XIII.) give the same data for the totality of stars from the first to about the eleventh magnitude. The following table is thereby obtained:—

Table I.

I.	II.	III.	IV.	V.	VI.	VII.
Magnitude.	C. & D.	A. & B.	Surplus on the side of C. & D.	D.	A.	Surplus on the side of D.
1–6·5 B.D.	9	8	+1	4	4	0
6·6–7·0 „	17	11	+6	10	3	+7
7·1–7·5 „	16	18	−2	11	6	+5
7·6–8·0 „	27	36	−9	14	23	−9
8·1–8·5 „	64	78	−14	37	38	−1
8·6–9·0 „	185	171	+14	110	73	+37
9·1–9·5 „	1035	955	+80	565	432	+134
1–11 ? Celoria	4476	2924	+1552	2658	1189	+1469
Milky Way ...	Luminous	Feeble	(+)	Very Luminous	Very Feeble	(+)

A correspondence between the distribution of the relatively bright stars and the brightness of the Milky Way is seen to show itself about the ninth magnitude. As regards the Celoria stars, the surplus of the stars in the region where there is the greatest Galactic light amounts to more than the half of all the stars found on an equal superficies in the opposite region. The correspondence shows itself a little earlier, and is much more marked when comparing the regions A and D, where the contrast of the Galactic brightness is the strongest.

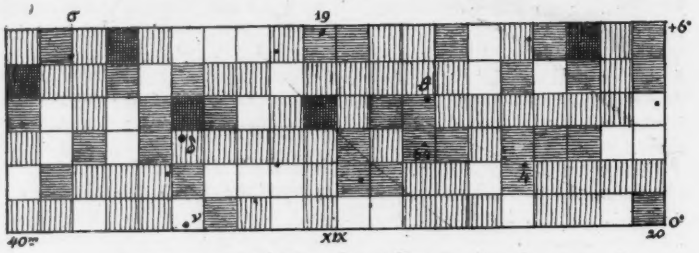


Fig. 2.—Diagram indicating the stellar density for Stars of magnitude 7·6—9·0. (Argelander.)

Of the diagrams accompanying this article, Fig. 1 represents isophotic lines of the Milky Way as seen by direct observation with the naked eye, and is from drawings (unpublished) by Mr. Ant. Pannekoek, of Leyden; Fig. 2 is a diagram showing the numbers of the stars of magnitudes 7·6—9·0 (Argelander), the darkest tints corresponding to the greatest density. No correspondence is shown with the arrangement of the brighter or fainter regions of the Milky Way. In Fig. 3 an analogous diagram is given for the stars of the lowest class of Argelander's magnitudes, 9.1—9·5, and the configuration of the Galactic image is already beginning to manifest itself. The great rift between the two main branches of the Milky Way, the condensation towards δ and σ, the feeble regions between δ and ν and δ and 19 are well defined. The diagram from the stars counted by Celoria, 1-11 magnitude (Fig. 4), shows these details more clearly still. Fig. 5 is a reduced reproduction (scale one-sixteenth) of the map in the Bonn atlas corresponding to this region of the heavens; thus all the stars of the first to the ninth or tenth magnitude are to be seen, so to speak, condensed—and a simple glance on this map and on the drawings of the Milky Way will suffice to prove—a conclusion arrived at also upon examination of the large celestial photographs—that a certain number of relatively bright stars (1-9 magnitude) already co-operate in the formation of the Milky Way properly so-called.

The results obtained for this region in the constellation of the Eagle are confirmed in a remarkable way, if a more extended zone is now considered, sufficiently distant from the first, and situated in the constellation of the Swan, between R.A. 20h. 20m. and 21h. 40m., N. Decl. 40° to 55°. It contains one of the most brilliant spots (α to A Cygni) and one of the most sombre spots (the "Northern coal sack") in the whole of the Milky Way.

After having determined the details for which an accord might be established between the greater part of the observations of the Milky Way, I have divided the zone into a certain number of trapezia, so that for each division it becomes possible to give a value corresponding to the brilliancy of the Milky Way in this place. As a luminous streak extends from f¹ to 7411 B.A.C., the band 47° to 48°, having too much influence on the rather low value which suits the division R.A. 20h. 52m. to 21h. 16m.; N. Decl. 48° to 50°, is not taken into consideration. The number I. for the brilliancy of the Galactic brightness corresponds

* See Easton, "The Milky Way in the Northern Hemisphere."

to "very feeble," II. to "feeble," V. to "luminous," VI. to "very luminous," etc.

On comparing the stellar densities for the stars 9·1 to 9·5, with my map of the Milky Way in this part of the heavens, it is found that the feeblest densities correspond to the places where the Milky Way presents the least brilliancy, and that the density is the greatest there where the intensity of the Galactic glimmer is the strongest. As in default of a good photometric method, the values I., IV., etc., for the intensity of the Galactic brightness cannot always represent one and the same intensity, a comparison of the contrasts offered by neighbouring regions should above all be made. Table II., representing the differences in the densities, has been added for this reason.

Table II.

I.	II.	III.	IV.	V.
Divisions.	Difference of Brilliancy Milky Way.	Difference of Stellar Density, 1–9·0.	Difference of Stellar Density, 8·1–9·0.	Difference of Stellar Density, 9·1–9·5.
A—B	–I.	+2·05	+1·02	–2·41
C—D	–I.	+0·71	+0·47	–2·95
D—E	–I.	–2·46	–0·59	+0·12
E—F	–I.	+0·59	+1·19	–2·94
F—G	+I.	–0·61	–2·37	+3·06
G—H	–I.	–0·23	+0·60	–3·65
I—K	+I.	–3·53	–2·90	+4·16
K—L	–II.	–0·63	–1·26	–6·18
M—N	+I.	+1·97	+1·89	+4·66
N—O	–I.	–1·60	–1·16	–4·01

Excepting the zone where the "coal sack" (M-O) is found, and where the correspondence shows clearly from the seventh magnitude, it is seen that the group 9·1 to 9·5 is the only one for which the signs correspond nearly everywhere with those of the col. II.

With the exception of a single instance (D-E)—of small importance, and which may be attributed to an

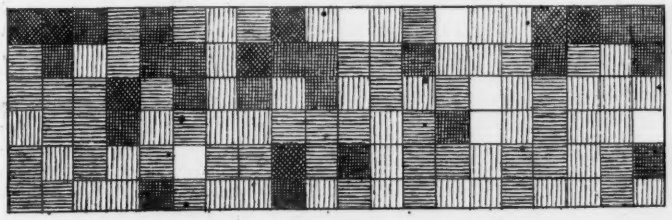


Fig. 3.—Diagram indicating the stellar density for Stars of magnitude 9·1—9·5. (Argelander.)

erroneous estimate of the average brilliancy of the Milky Way in this region—it appears from the preceding tables as well as from the table representing the results obtained from the zone in the Eagle, that the stars of the last class of Argelander already present, by the manner in which they are distributed, a remarkable correspondence with the luminous and obscure spots of the Milky Way.

For this region it has been possible to compare one with the other a rather large number of stellar gauges by William Herschel (*Pub. Washburn* II.), and the unpublished gauges that Dr. Th. Epstein of Frankfort-on-Main

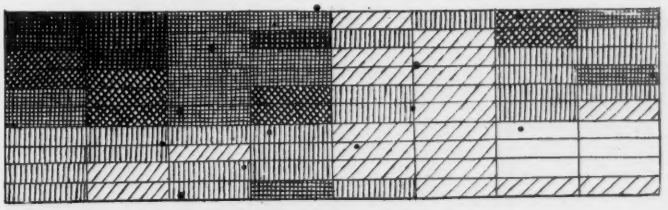


Fig. 4.—Diagram indicating the stellar density for Stars of magnitude 1—11. (Celoria.)

has been good enough to communicate to me; and to complete these data by countings carried out for the same regions on the Bonn atlas, and on Max Wolf's two photographs, reproduced in Knowledge, December, 1891. The limits of the magnitudes are naturally only given approximately. On combining these results for the places where the Milky Way presents either a feeble intensity, a strong intensity, or an average intensity, the following table is obtained for the averages of the number of stars found on a superficies of 1400 square minutes (the superficies of the Epstein gauges), for the columns II to V., compared with the averages of the Herschel gauges.

Table III.

I.	II.	III.	IV.	V.	VI.
	1400 Square Minutes.				Field of 15′ diameter.
Milky Way.	Argelander 1–10.	Wolf, A. 1–11·3.	Epstein. 1–12.	Wolf, B. 1–13·2	Herschel 1–15.
Feeble	9·	28·	65·5	165·	24·3
Average	12·7	52·3	85·7	297·	202·
Strong	18·5	84·5	127·4	492·6	340·

We have found that the maxima and the minima of the stars of the 9th, 12th, 15th magnitudes fall in the same places of the heavens, often with astonishing precision, and this in rather extended zones and which embrace nearly the whole of the breadth of the Milky Way. This does not mean that such will be the case for all regions of the heavens; such a supposition, indeed, is very improbable. But that such a coincidence, occurring so often, can be a mere chance is hardly admissible; thus it cannot be here a matter of groups independent one of the other. Besides, in all cases where these condensations have an appreciable Galactic latitude, it would have to be admitted that the real latitudes of the groups situate at divers distances in the direction of our visual ray were, for each one of them, nearly exactly proportionate to the distances, which would seem absurd.

It is true that a hypothetical stellar ring, from which extend protuberances in the direction of our visual rays, would give rise to an analogous phenomenon to that which we have just stated. But in order to explain all the facts, particularly the circumstances that the correlation which has been found is just as often met with in the very feeble regions as in the luminous regions, it must be admitted that the length of these protuberances must be relatively slight. This circumstance, and the com-

plication of the Galactic image in nearly all its parts, renders it difficult for us to believe that in all these cases

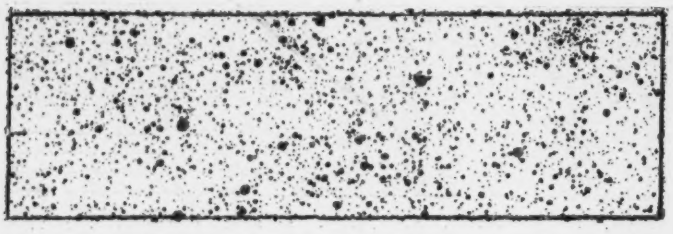


FIG. 5.—Reduction of part of the Bonn Atlas, in Aquila. (Argelander.)

we have only penetrated into irregular masses, accidentally brought rather near to us, but which do not belong to a zone of great extent.

In short, if the results given in the preceding paper are considered, the conclusion most forcibly presented to us is, that it becomes extremely probable that the great majority of the fainter stars of the Milky Way—so far as their existence is revealed to us by photography or direct vision—are not much more distant from us than the stars of the ninth and tenth magnitudes, at least in the regions to which our researches have extended. The Galactic system, or at any rate that portion which is accessible to our means of observation, must thus have but little depth in proportion to its diameter.

The extension of the researches here given to the whole of the Milky Way may throw more light upon these problems. But at first it would be necessary to possess a greater number of observations on the aspect of the Milky Way with the naked eye.*

CLUSTER M. 46, AND NEBULA H IV. 39 ARGÛS.

R.A. 7h. 37m., Decl. S. 14° 30′.

THE photograph covers the region between R.A. 7h. 35m. 39s., and R.A. 7h. 38m. 54s.; Decl., between 14° 0′ and 15° 14′ South.

Scale, 1 millimètre to 23·61 seconds of arc.

Co-ordinates for the epoch A.D. 1900 of the Fiducial stars marked with dots.

Star (•). D.M., No. 2082. Zone—14°. R.A., 7h. 35m. 48·7s. Decl., S. 15° 1·9′. Mag., 5·4.

Star (‥). D.M., No. 2099. Zone—14°. R.A., 7h. 36m. 28·5s. Decl., S. 14° 49·9′. Mag., 8·7.

Star (⁘). D.M., No. 2158. Zone—14°. R.A., 7h. 38m. 3·6s. Decl., S. 14° 7·2′. Mag., 8·6.

Star (::). D.M., No. 2171. Zone—14°. R.A., 7h. 38m. 20·3s. Decl., S. 14° 46·4′. Mag., 8·8.

The photograph was taken with the 20-inch reflector on February 24th, 1894, between sidereal time 6h. 2m. and 7h. 32m., with an exposure of the plate during ninety minutes.

REFERENCES.

The cluster is N. G. C. No. 2437, G. C. No. 1564, and h 463. The nebula is N. G. C. No. 2438, G. C. No. 1565, and h 464 = 3093.

Sir J. Herschel (G. C.) describes the cluster as a remarkable object, very bright, very large, very rich, with a planetary nebula involved, which he describes as pretty bright, pretty small, extremely little extended, barely resolvable; 3·75s. in diameter.

Lord Rosse (*Phil. Trans.*, 1850, p. 513, Pl. XXXVIII., Fig. 12; and *Obs. of Neb. and Cl. of St.*, p. 61) records twenty-one observations of the nebula made between the years 1848 and 1876. He saw it first as a planetary nebula 60″ in diameter, and subsequently as an annular nebula with two stars and a suspected third star in it. Much uncertainty as to the character of the object is shown by the records, and in the last observation (1876) he says, "It can hardly be called a planetary nebula." The star north preceding the centre is estimated as of 13th–14th magnitude, and the other star near the *following* edge 16th magnitude.

Lassell (*Mem. R.A.S.*, Vol. XXIII., p. 60, Pl. II. Fig. 5) describes it as a planetary nebula, and saw two stars in it.

The photograph shows the nebula to be of the annular type, and as perfect in outline as M 57 Lyræ, and is seen projected on a plane facing the eye, and circular in form. The ring is most condensed on the north following side, and there are three stars in the interior. The brightest of them (13th–14th magnitude) is near the centre; another, of about 16th magnitude, is on the south preceding side; and the third, which is below 16th magnitude, is almost involved in the ring on the south following side. There is also evidence of very faint nebulosity in the ring itself.

The nebula is either involved or else in alignment with the northern part of the cluster, which is a magnificent aggregation of stars between the 9th and 16th magnitude, and the photo-fields around it are crowded with stars having the usual remarkable groupings and numerous apparent double, triple, and multiple stars.

Letters.

[The Editor does not hold himself responsible for the opinions or statements of correspondents.]

FLUCTUATIONS OF MIRA CETI.

To the Editor of KNOWLEDGE.

SIR,—The discussion on Mira Ceti can well wait further evidence, which I feel confident will be forthcoming in good time, but for your satisfaction I submit the following.

According to "The Companion to the Observatory" for 1895 the maximum of Mira Ceti occurs on January 13th this year: but on that day the star was only of the seventh magnitude, fully five magnitudes less than the maximum in light, and less than 66, 67 and 71 Ceti, with which I compared it until it exceeded them in light, when I used δ and γ in the same constellation.

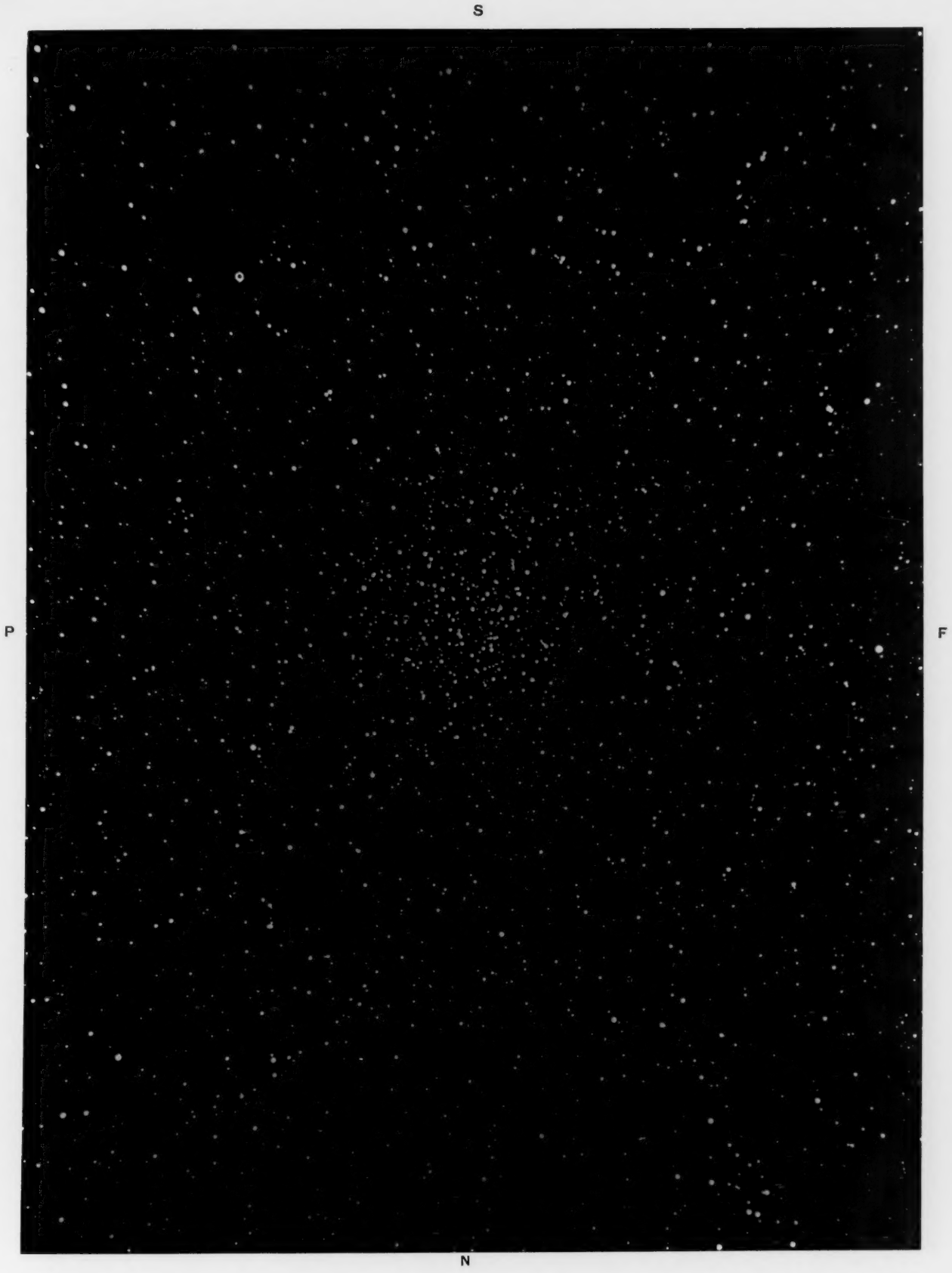
My record reads:—

February 9th	...	δ 4·0, O 9·66
February 16th	...	0·5 δ, γ 5·0
February 24th	...	0·5 δ, γ 5·0

This, in my opinion, was the maximum light given by Mira this season, and it lasted about ten days.

I felt dissatisfied with the figures between January 13th and February 9th and between February 9th and 24th, and attributed their seeming inconsistency to my own personality. As I was in doubt, however, and was unwilling to run in vain, I addressed an astronomer, whose name, did I feel at liberty to publish it, would be sufficient support of my

* Some astronomers, both professional and amateur, in Germany and France have offered to assist me by sending me some observations of the Milky Way in order that I may collate them and publish a summary of them later on. I should be very pleased if, among the fellow-countrymen of Lassell, Marth, and Boeddicker, a large number of persons were found who would wish to participate in a similar systematic investigation of the Milky Way with the naked eye, and who would send me their address in sign of their desire to co-operate in the work.



PHOTOGRAPH OF THE CLUSTER MESSIER 46, AND THE NEBULA HERSCHEL IV. 39 ARGÛS,
by ISAAC ROBERTS, D.Sc., F.R.S.

Direct Photo Engraving Co., 9, Barnsbury Park, N.

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statement, and he replied, February 20th, saying, "Mira has just had two maxima."

My record continued reads :—

March 2nd ...	0·2 δ, γ 7·0
March 5th ...	0·4 δ, γ 8·0
March 8th ...	0·4 δ, γ 7·0
March 12th ...	Moonlight and cirrus.
March 16th ...	0·3 δ.

From these figures it appears that there were other changes in light, and on March 20th the same astronomer wrote me, "Mira fluctuated greatly. My last observation, March 14th, 4·32. It then became impossible to observe it in consequence of the companion stars being too near the horizon for accuracy at such a distance, &c." Please notice the photometric estimate, 4·32, and my visual estimates, March 8th and 16th ;—δ is 4·2 magnitude. There was no apparent change in Mira from March 16th to 20th, when it had fallen too low in the city smoke and vapour for safe comparison with stars so far above it.

Herr Plassmann's maximum reminds me of a note in *Nature*, March 8th, 1894, p. 442, which says that, "although the maximum of Mira was predicted for February 17th, yet on March 4th it was only a trifle brighter than δ, a star of 4·2 magnitude." The maxima of 1894 and 1895 are in accord and doubtless follow Argelander, but Herr Plassmann's maximum indicates a correction of thirty days, not generally known, or at least accepted. There is a coincidence, however, between his date and this year's observations here.

Col. Markwick has treated the matter broadly and comprehensively, and I am highly gratified to be in agreement with so distinguished an authority. I beg to call his attention, however, to a statement in Webb's "Celestial Objects," volume II., that Mira is not always ruddy. If there was a tinge of red in it this year it escaped my notice.

Mr. Peek holds, I submit, an extreme view on visual observations, and the record above affords some little evidence that a fair degree of accuracy may be reached. Of course it requires pains, a good eye, and steady atmosphere. Some excellent work of this kind has been done in this country. There is a triplet of variable star observers in Massachusetts, Messrs. Chandler, Yendell, and Sawyer. The last-named works with a field glass, while the others have all the modern appliances, and they wait a long time for his concurrence before making an announcement, thus showing a high appreciation of visual observations. Their work is well known.

In conclusion I would say that my observations have been recorded nightly, according to my best judgment, and without any reference to any previous entries.

I enclose the notes of the astronomer alluded to for your inspection.

Yours truly,

DAVID FLANERY.

Memphis, Tenn.,
12th June, 1895.

COLOURS OF BUTTERFLIES.

To the Editor of KNOWLEDGE.

SIR,—In your July number, Mr. Miller, in criticizing Dr. Marshall's paper upon this subject (*ante*, p. 128), draws from it a number of conclusions that he says are "plainly deducible," but at which I am at a loss to see how he can arrive.

Mr. Miller asks why some insects are protected and others are not, and why the latter have survived if protective colouring is a necessary clause.

In answer I would point out that the fact that many forms do exist without the aid of special protection, is conclusive proof that in such cases special protection is unnecessary. This is obviously a truism.

Special adaptability to an environment is the direct result of high competition, and the higher this competition, the fiercer this struggle between the offensive and defensive forces at work, the sooner, on either side, will approximate perfection be attained.

This perfection is reached, not merely by the production of strong forms, but by the weeding out of the weak ones, and as such a process necessarily entails an extra expenditure of energy in the reproductive system, the tendency would be for every organism to remain in as imperfect a condition as its environment would permit.

Hence, to me, it would appear to be the rule that a special amount of protective form or colouring is exhibited only where an exceptional opposition from numerous or powerful enemies has to be met ; and, inversely, that where an organism shows no close sympathy with its surroundings, the struggle for existence is not severe.

Mr. Miller asks why do not all butterflies follow the clever example of their mimicking fellows ? He is looking at the subject quite from the wrong side. The active agent, natural selection, which adapts an organism to its position, is not an internal, but an external force. It is the environment alone which sorts out the bad forms from the good, the "goats from the sheep," and by destroying the former, allows only the latter to inter-breed. Unless the enemies of an insect are numerous enough, or powerful enough, to weed out its weaker forms, that insect can never, except by mere chance, advance one step towards perfection.

Mr. Miller points out that insects using warning colours "are so considerate as to protect even their enemies from injury." This may be so, but it is only from egoistical motives, and therefore has no serious bearing upon the matter. In the myriad dovetailings between the economy of one animal or plant and another, it would indeed be strange if some coincidences of mutual aid did not arise. But can Mr. Miller quote a single instance where any animal or plant behaves in such a way as to benefit another individual or species, to the final injury of itself, or of its type ? That would be a real obstacle to get over.

Finally, Mr. Miller raises objection to the word "mimicry," because he says that such a term implies the presence of a degree of intelligence in the insect world, such as he, very properly, cannot allow of. As I have, however, already pointed out, "mimicry" results from the action of natural selection, and as natural selection is altogether an environmental force, no demand whatever is laid upon the intelligence of the insect. In favour of this view let me quote a single case.

When that pretty little moth, *Labophora viretata*, first emerges from its pupal skin, it is of a beautifully bright green colour, exactly matching in tint the holly trunks upon which it rests. After it has been "out" a few days, this green changes to yellow, and those moths which still maintain their position upon the bark are made conspicuous objects for any passing enemy. Before that time, however, all the fertilized females have mounted to the higher branches, to lay their eggs among the flowers. Thus only the males and the unfertilized females are left upon the tree trunks, and as both these two are of the least importance in the economy of the type, natural selection has left them alone to the mercy of their foes. That such yellow forms rest upon the green bark shows that the insects themselves appreciate neither

their adaptability nor their inadaptability to their environment.

For all that, the word "mimicry" does, as Mr. Miller observes, imply conscious selection on the part of the insect, though I feel convinced all modern writers have employed the term merely in a metaphorical sense, and because they could find no better. Can Mr. Miller propose a better one? I do not think we have quite the right one anywhere in our language; but so that future misunderstandings might be avoided, would it not be well to coin one?—one made expressly for the purpose, and having no other outside meaning, so that misinterpretation would be impossible. Might I suggest such a word as "ensemblance," and instead of speaking of one insect mimicking another, say that it "ensembles" it?

Yours faithfully,

Alfred J. Johnson.

Baldmere, July 18th, 1895.

To the Editor of Knowledge.

Sir,—In reply to your correspondent, Mr. Miller, I beg to state that my article on the above subject was intended to be simply a brief and popular account of the work done by Darwin and Wallace, and further elaborated by Poulton and others. That many difficulties arise in discussing these problems is well known, and many of the difficult points of natural selection are still unexplained. In fact, many biologists at the present time simply adhere to the theory of natural selection as a working hypothesis because it is the one which is most compatible with known facts, not because it will explain everything.

Mr. Miller objects to the term "mimicry" in that it implies conscious effort on the part of the mimicking insect. But the essence of the theory of natural selection, as opposed to the older theory of Lamarck, is that there is no conscious effort on the part of the individual, but that an accidental resemblance, at first slight, becomes increased in successive generations by hereditary transmission of peculiarities to the offspring, and by the survival of the fittest, those more nearly resembling the mimicked and protected species surviving.

Again, Mr. Miller says it will be seen from my paper that "the inferences drawn from the facts related are that those butterflies which are thus protected survive, while those that are unprotected perish, or at least are liable to destruction."

Because it is a fact that certain insects so nearly resemble their surroundings or other insects that it is almost impossible to distinguish them, and that they are thus passed over or avoided by their enemies, it does not follow that protection of this kind is *necessary*—as Mr. Miller says I "seem to say"—for the preservation of the life of every insect. Protective resemblance, warning colours, and mimicry are not the only means by which an insect escapes destruction. There are others, amongst which the power of rapid flight, and habits of concealment, especially in the daytime, might be mentioned. Moreover, there are many insects which do not require protection, owing to the fact that they have few enemies in the localities where they exist.

Finally Mr. Miller says: "What has all this to do with the origin of species?" I fear it would take several whole numbers of Knowledge to answer this question. I can only refer Mr. Miller to a certain book on the subject by one Charles Darwin.

Yours truly,

C. F. Marshall.

Science Note.

The Society for the Protection of Birds has sent us two new pamphlets, one on the owl, by Mr. W. H. Hudson, and another on the bird of paradise, by Mrs. F. E. Lemon, the honorary secretary of the society. The fact that owls of all kinds are extremely useful as destroyers of rats and mice is becoming gradually recognized by farmers and game preservers, and it is encouraging to learn that several county councils have already included in their lists of the eggs of birds to be specially protected under the new Act those of the owls. There is, however, as Mr. Hudson points out, a barbarous machine called the pole trap, which, although intended to catch hawks, is, nevertheless, equally destructive to owls, and until the setting of this trap is forbidden by law, owls will never become plentiful in this country. The leaflet on the bird of paradise is an appeal to women throughout the world to discountenance the sacrifice of this marvellous and beautiful bird, which is daily becoming rarer, by refusing to wear or purchase their feathers.

Notices of Books.

The Science and Art of Breadmaking. By William Jago, F.I.C. (Simpkin, Marshall & Co.) Mr. Jago has for many years devoted special attention to the chemistry and analytic and practical testing of wheat, flour, and other materials employed in breadmaking, and is therefore well qualified to undertake the writing of a book on the science and art of breadmaking. The present volume is, however, only an extension of the author's former book on the same subject; but as many additions have been made, the present volume forms a valuable compendium of our knowledge of this important industry. The book is, moreover, complete, inasmuch as the author has taken pains to include in the introductory chapters so much elementary chemistry and physical methods of analysis as will enable the reader to follow the more specialized sections which follow. The chapter on the enzymes is exceedingly well written, and is well up to date; but we must object to the author's word "diastasis," which he has coined for diastasic action. Surely, if a new word is needed, diastalysis would be more accurate. We note further, under the heading of substances inimical to diastasis, no mention among the usual preservatives, such as boric and salicylic acids, of "formalin," which has recently been introduced as a food preservative. The more technical portions of the book may be somewhat out of the scope of many of our readers, but should prove of value to the practical baker and confectioner, as the author has devoted considerable space to the discussion of modern breadmaking plant, and to the best methods of bakehouse design. After the recent strictures passed by Dr. Waldo and others upon the unsanitary condition of London bakehouses, it seems essential that some such book as this should be in the hands of those concerned in the erection or management of bakehouses, and as we understand considerable improvement has been brought about in Bristol as the result of the agitation, we hope that all interested in this subject will get Mr. Jago's book, so as to be posted up in the details of design which are so essential in securing convenient and sanitary bakehouses. The last four chapters are devoted to the methods of analysis of bread, flours, malt extracts, and other materials used in breadmaking. The whole book is exceedingly practical in its scope and treatment, and great pains have been taken to bring the subject well up to date.

Practical Microscopy. By George E. Davis, F.R.M.S., F.I.C. Pp. 436. (W. H. Allen & Co.) This is the third edition of what is essentially a practical work, very little space being given to the theory of microscopy. It is a work which will enable the microscopist to thoroughly understand the capabilities of the instrument he uses, and initiate him into the operations carried out by means of accessories to it. All branches of microscopical work are dealt with, and if the student follows out the instructions, he will acquire expertness in manipulation and the ability to observe.

A First Book of Electricity and Magnetism. By W. Perren Maycock, M.I.E.E. Pp. 233. Second Edition. (Whittaker & Co.) Young and ill-educated beginners of the study of electricity and magnetism will find this volume a suitable and really elementary text-book. The simplest language is employed throughout; nevertheless, the student who has gone carefully through the book will have acquired a sound knowledge of the subjects dealt with.

BOOKS RECEIVED.

Nature versus Natural Selection; an Essay on Organic Evolution. By Charles Clement Coe. (Swan Sonnenschein.) 10s. 6d.

The Cell—outlines of General Anatomy and Physiology. By Dr. Oscar Hertwig. Translated by M. Campbell, and edited by Henry Johnstone Campbell. (Swan Sonnenschein.) Illustrated. 12s.

Architecture for General Readers. By H. Heathcote Statham. (Chapman & Hall.) Illustrated.

The Structure and Life of Birds. By F. W. Headley. (Macmillan.) Illustrated. 7s. 6d.

A Chapter on Birds. Rare British Visitors. By R. Bowdler Sharpe. (S. P. C. K.) Illustrated. 3s. 6d.

The Natural History of Aquatic Insects. By Prof. L. C. Miall. (Macmillan.) Illustrated. 6s.

An Introduction to Chemical Crystallography. By Andreas Fock. Translated and edited by W. J. Pope. (Oxford: The Clarendon Press.) 5s.

The Climates of the Geological Past, and their relation to the Evolution of the Sun. By Eug. Dubois. (Swan Sonnenschein.) 3s. 6d.

Allen's Naturalist's Library; a Hand-book to the Game Birds. Vol. I. By W. R. Ogilvie-Grant. (W. H. Allen.) Illustrated. 6s.

A Thousand Answers to a Thousand Questions. (Geo. Newnes.) 2s. 6d.

Astronomers and their Observatories. By Lucy Taylor; with a preface by W. Thynne Lynn. (Partridge.) 1s. 6d.

An Analysis of Astronomical Motion. By Henry Pratt, M.D. (Norman & Son.)

Chemists and their Wonders. By F. M. Holmes. (Partridge.) Illustrated. 1s. 6d.

The Story of the Plants. By Grant Allen. (Geo. Newnes.) Illustrated. 1s.

Garden Flowers and Plants; a Primer for Amateurs. By J. Wright. (Macmillan.) Illustrated. 1s.

Microbes and Disease Demons. By Ed. Berdoe. (Swan Sonnenschein.) 1s.

A Summer Holiday in Holland. By Chantrey Churchill. (H. Grube.) 6d.

The Study of Atmospheric Currents by the aid of Large Telescopes. By A. E. Douglass. Reprinted from the *Meteorological Journal*, March, 1895.

A DAY ON A SCOTCH MOOR.

By Harry F. Witherby.

To most people and to sportsmen specially a moor is better known, either by description or personal experience, in the autumn when the heather is blooming and the grouse are flying than in the spring. From a naturalist's point of view, however, a Scotch moor is much more interesting about the middle of May than on the 12th of August.

It is my intention in this paper to describe what was seen by myself and three companions on a certain 20th of May spent on a Scotch moor.

Making an early start in brilliant sunshine, we walked steadily along a dusty, uphill road for about seven miles, until the moor was reached. The only object of interest passed on the road was a gigantic pigeon house, and as these houses are now becoming rather scarce, it may be worth while to make a digression here, and say something concerning the one we saw. It was about fifteen feet square and twenty-five feet high, looking like a house without windows. The roof was built in the form of a flight of steps, in the "risers" of which holes were cut for the pigeons to go in and out. Inside the house, shelves were arranged on which the pigeons nest. The house, which belonged to "the Laird," could accommodate several hundred pairs of pigeons; but I was told that it was by no means the largest in the district. The pigeons kept in these large houses are not as a rule fed, but obtain their living from the neighbouring farms. Many pages might be written upon the construction of these houses, where they are to be found, and the old laws relating to them, but space forbids.

At length the edge of the moor appeared in sight; but before it could be reached it was necessary to cross a deep and exceedingly narrow glen, down the centre of which there flowed a little stream, or burn, as the Scotsman calls it. Although the sides of the glen were very steep, they were thickly covered with trees and undergrowth. Once across the glen, we were on the moor, but the stream proved a serious obstacle to at least one of our party. Its sides were steep and overgrown with nettles, and to both stream and nettles our friend fell a victim.

On the other side of the burn we all lay down in the heather, and after enjoying a quarter of an hour's rest, we walked on and soon arrived at a shepherd's cottage, the owner of which was known to some of our party.

Nest and Eggs of the Red Grouse.

As I was anxious to obtain a photograph of a grouse[1] on the nest, the shepherd led us to one, but although the bird allowed me to approach within five feet of her as she sat on the nest among the heather, the result was in no way satisfactory.

[1] Red Grouse (*Lagopus scoticus*).

A pair of golden plovers,[2] screaming as they flew round us, next attracted our attention. In common with several birds, such as the curlew, which are generally to be found on the coast in winter, the golden plover comes inland in the spring and breeds on the moors and marshes. They make no regular nest, but lay their four large pear-shaped eggs in a little scrape in the ground, which makes them difficult to find. The young are still more difficult to discover. They are able to run as soon as they are hatched, and directly the parent birds give the alarm note, they instinctively hide in the grass and keep perfectly still. Moreover, the parent birds are very clever at drawing the uninitiated away from their eggs or young. Thus the young bird has every chance of surviving, and coupled with the fact that it is a hardy bird, one would think that the golden plover would increase rapidly; but in the autumn, when they are excellent eating, thousands are shot, as they move about the country in great flocks.

In the very heart of the moor we came upon a small fir wood, from out of which several black grouse[3] flew as we approached. The black-cock, as the male bird is called, is polygamous, and is accompanied in the breeding season by several grey-hens. They are late breeders, and had only just commenced to lay. We found two eggs, both laid upon the bare ground in different parts of the wood, and without any pretence to a nest or even a scrape. We flushed the bird from one which was evidently only just laid. The egg was placed amongst the roots of a tree in such a position that a nest could not have been formed on that particular spot; the other egg we found under a thick bush, also an unlikely place for a nest. It would seem from this that the black grouse, like ducks and other birds, lays several eggs before making a nest. Then it either makes a nest in a convenient spot, and in some manner transports the eggs already laid to it, or else it gradually forms a nest round the eggs. I can gain no further information on this subject, and shall be glad if any of the readers of KNOWLEDGE interested in this point will give me their own experiences.

We had left the wood and were spread out across the moor searching for nests, when suddenly a blinding snow-storm came on. The morning had been balmy and warm, but we were now in the midst of a regular winter storm. We closed up together, and two of us with the shepherd and his collies took shelter behind a wide board, which we chanced upon. While we were crouching an old grouse began to fly round in a restless manner, while every now and then she alighted a little way off and made an anxious noise. Presently we heard a "cheep" and then another, ten yards or so away, and we guessed that they were young grouse. One of us began clucking like a hen in the hope of attracting the young chicks, when very much to our surprise the "cheeping" sound grew nearer, and soon eight tiny grouse came running through the snow to the call. There was a little rivulet between them and us, and as we were wondering what the chicks would do every one ran blindly into it. We got them all out and brooded them in our hands until the storm had blown over, and then we went away and left them to their anxious mother.

By this time the whole moor was completely white—a curious phenomenon in summer! It revealed a very striking fact in regard to the protective colour of birds. Now the grouse could be seen on all sides, even to the distance of half a mile, brooding their young, so dark did they appear against the snow, whilst previously, one almost stepped on them before seeing them. Another curious fact consequent upon the snow falling in summer was made apparent. All the birds having naturally covered their eggs or young, immediately the snow began to fall, green patches were left where the eggs or young had been, the contrast being very strong between the whiteness of the snow and the vivid green of the grass or dark brown of the heather. A curlew's[4] nest, for instance, which we found, while the snow still covered the ground, was very conspicuous, and could be seen for some distance.

Nest and Eggs of the Curlew.

It was getting rather late and another very heavy snow-storm came on, so we returned to the shepherd's cottage. While we were waiting for the weather to clear, a pair of ring-ouzels,[5] which were hopping about quite close to the house, attracted our attention. Ring-ouzels, or "hill-blackies," as they are called in Scotland, are not unlike blackbirds, the cock being black and the hen brown, but the distinctive feature in their plumage is a white collar round the throat. They were diligently collecting insects, and evidently had young not far off. We saw them fly away and come back again several times, and then we followed them. For a whole hour we watched the crafty birds with our field glasses before we could track them to the nest. We were on one side of a wide ravine and they were on the other amongst some juniper bushes, one of which we were sure contained the nest. But they flew backwards and forwards from bush to bush, then one of them would take a worm in its bill and fly into a bush with it, and we would make sure the nest was there, but no, it was only a ruse, the bird would come out in a minute or so and go to another bush. All this time they kept up an incessant noise something like a blackbird's alarm note, but rather harsher and slower, more like a fieldfare's click, clack; the cock bird was especially noisy. At last we tracked them down, and leaving one of our party to keep his glass fixed on the spot, the rest rushed across the ravine up to the juniper bush we had marked, and found the nest in a branch touching the ground. It was very compact and much like that of a blackbird. The nest contained three young birds nearly fledged, and although late in the afternoon and rather dark, I still managed to get a photograph good enough for my purpose, which was to keep a record of the position and appearance of the nest in its natural situation.

[2] Golden Plover (*Charadrius pluvialis*).
[3] Black Grouse (*Tetrao tetrix*).
[4] Common Curlew (*Numenius arquata*).
[5] Ring-ouzel (*Turdus torquatus*).

Our walk home was none too pleasant, for it rained heavily the whole way, and we arrived at our quarters about 10 p.m., soaked to the skin, footsore, and ravenously hungry, but with a lively sense of the manifold interests of a Scotch moor.

THE EXPLORATION OF THE SURFACE OF THE GLOBE.

By Prof. J. Logan Lobley, F.G.S.

THE meeting of the sixth International Geographical Congress in London compels attention to the great subject of the exploration of the surface of the globe, and to the progress that has been made towards its completion. An estimate, therefore, of the area yet unexplored may prove of interest to the readers of Knowledge.

During the sixty years comprising the last decade of the fifteenth and the first half of the sixteenth century, the greater portion of the earth's surface was made known to mankind. It was during these years that Sebastian d'Elcano first circumnavigated the globe; that Vasco de Gama first doubled the Cape of Good Hope, and that the two Americas were added to the map of the world by the voyages of Columbus, the two Cabots, and Magellan. Australia, too, then first appeared in European maps, for in a French chart of 1542 we find the island-continent included under the name of "Jave la Grand."

Since the middle of the sixteenth century every sea, except those within the Arctic and Antarctic Circles, has been traversed in all directions, and very many islands, large and small, have been discovered. We are justified, therefore, in assuming that all the land areas of the globe are known in position and extent, with the exception of what may be hidden behind the northern and southern ice. But although the position and extent of practically all the land areas of the globe are known, regions of vast extent remain unexplored, and an immense aggregate area, though generally known and mapped, has not yet been explored in detail, much less accurately surveyed. Moreover, there are extensive regions which, although they have been mapped in considerable detail, require much more careful exploration than they have yet received before entirely reliable maps of their surface features can be produced.

Of the altogether unexplored regions of continental land undoubtedly the largest aggregate area is still in the African continent, notwithstanding the gigantic strides exploration there has made during the present century, and especially during its latter half. African explorers, from Bruce and Mungo Park down to Livingstone and Stanley, and those still in the field, have gradually changed the map of Africa from what was little more than the outline of a great continent to an area largely chequered with detail. The latest exploration of the heart of Africa was made so recently as last year by Count Götzen, who crossed the continent from Pangani, on the eastern coast, to Kirmeder, south of Stanley Falls on the Congo, by which river he reached the western coast. This journey has given to geography the lake Umburre, five crater lakes, and the volcano Kirmega Lchagongo, besides much valuable information respecting the country traversed and its inhabitants.

The unexplored parts of Africa form an aggregate area, however, very far exceeding that explored, while the well-surveyed area of the continent is but a small proportion of the whole. The regions unexplored comprise:—

1. The immense area of North Africa usually called the Sahara, or Great, or Libyan, Desert, lying between lat. 30° N. and lat. 15° N., and long. 30° E. and long 15° W., and having an area of upwards of three millions of square miles.

2. An area of at least a quarter of a million of square miles north of the Gold Coast.

3. The eastern spur of the continent comprising Somali Land and Gallia Land, and containing fully three-quarters of a million of square miles.

4. The great central interior region extending from 10° N. lat. to 25° S. lat., and spreading eastwards from near the Atlantic coast to 25° E. long. and to 30° E. long. in its northern part. Though this great region has been repeatedly crossed, and the Congo and adjacent districts to some extent explored, yet there must be still two and a half millions of square miles of quite unexplored lands.

Thus we find that out of eleven million square miles, the whole area of the continent, at least six million five hundred thousand square miles remain unexplored.

Of the greater part of the remainder of Africa it can only be said that its chief physical features are known as the result of very incomplete exploration. Even the known and settled regions of South Africa have not to a great extent been surveyed by a geodetic triangulation, the necessity for which has been well pointed out by General E. F. Chapman, of the War Office, in a recent letter to the President of the Royal Geographical Society. He writes, in urging the subject as one requiring the attention of the International Congress:—"It appears to me that, great as has been the development of political and commercial interests in Africa during the past decade, our knowledge of the topography of the interior of the country has not made an advance by any means as important, and that there are large portions of that continent of which no accurate maps exist, although they have been for years under a civilized administration and occupied by settlers of European descent."

Although Australia was known as a large island in 1542, it was not until 1843 that the exploration of the entire coast was completed by the "Beagle" expedition, made so famous by the illustrious Darwin, and only about thirty years have elapsed since Stuart and the ill-fated Burke and Wills first traversed the area from south to north, while it has not yet been crossed from the eastern to the western shore. It may, therefore, be said that, with the exception of areas near the coast, the great interior remains unexplored, or only known along a few route lines. This area cannot be less than two and a quarter millions of square miles.

In a general sense, Asia as a whole has been explored, and yet there are vast regions in which the exploration has only proceeded far enough to give a knowledge of the more conspicuous physical features, This applies to the great bulk of Central and Northern Asia between lat. 40° N. and lat. 70° N., and long. 125° E. and long. 70° E., giving an area of at least five millions of square miles. North of the seventieth parallel there are about a quarter of a million square miles of unexplored lands.

America, both North and South, except the far north of North America and the narrow southern part of South America, may also be said to have been explored; but, as in Asia, there are vast regions of which only the larger features have received any attention. The exploring journey of Mr. F. Russell, of Ohio University (1892-4) from Lake Winnipeg by Lake Athabasca and Great Slave Lake to the Musk Ox Hills, near Bathurst Inlet, and back to Fort Providence by the Mackenzie River, has shown not

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only how very imperfect are the maps of the Great North-West, but how inaccurate they are even in the details that have been given. A very large portion of the interior of the northern part of South America has, too, been very cursorily explored.

The untraversed lands of the far north of North America, with the adjacent islands and Greenland to the seventy-fifth parallel, and even of Labrador and the North-East Territory,* are still so extensive that they give an aggregate area of fully a million and a half of square miles awaiting the explorer.

In South America, Patagonia and Fuegia apart from their coast lines are practically unknown lands, and so may be included amongst unexplored areas, to which they add half a million of square miles.

Besides continental lacunæ on our maps there are the interiors of many large islands, as New Guinea and Borneo, and the Arctic and Antarctic unexplored regions, which add largely to the unknown areas of the earth's surface. It will be safe to estimate such areas as are insular and outside the Arctic and Antarctic Circles at half a million of square miles.

Arctic navigators have penetrated to 83° 24′ N. lat., and thus have reached a point about four hundred and fifty miles only from the Pole, but it cannot be said that the area enclosed by the seventy-fifth parallel has been explored. There is, therefore, around the North Pole about three and a half millions of square miles of unexplored region.

The Antarctic regions have been much less explored than the Arctic, for only on one side has any deep penetration of the area within the Antarctic Circle been effected. Here 78° S. lat. was reached. Allowing for this, there will still be about five millions of square miles of unexplored region around the Southern Pole.

Thus it appears that, leaving out of account the very imperfectly known regions of Central Asia and the interior of the northern parts of both North and South America, as well as the similar areas of Africa and Australia, there is an aggregate area of about twenty millions of square miles of the surface of the globe as yet quite unexplored. This aggregate is made up as follows :—

Africa	6,500,000	square miles.
Australia	2,250,000	,,
North America	1,500,000	,,
South America	500,000	,,
Asia	250,000	,,
Islands	500,000	,,
Arctic Regions	3,500,000	,,
Antarctic Regions ...	5,000,000	,,
Total	20,000,000	,,

When we add to this great total not merely the enormous areas of only partially explored regions, but also those that though explored are not yet accurately surveyed, it will be seen that the field for further geographical exploration and research is abundantly wide ; for the globe cannot be said to be geographically conquered until all its physical features are accurately known and mapped, and all its habitable lands, at least, have been covered with the network of a complete geodetic triangulation. This great work, a work becoming increasingly more important to mankind, cannot fail to be greatly promoted by such a gathering of the world's foremost explorers as that now assembled in London.

* See "Explorations through the Interior of the Labrador Peninsula, 1893-4," by A. P. Low. *The Geographical Journal*, June, 1895.

THE NEW SEA-FISH HATCHERY AT DUNBAR.

By L. N. BADENOCH.

THERE can be, unhappily, no longer any doubt that a serious diminution has occurred amongst the more valuable classes of our food-fishes, especially on inshore grounds, and in comparison with the increase in the machinery of capture. The evidence of all those interested, whether trawlers or linesmen, whether smack owners or fishermen, whether scientific experts or statisticians, tends to prove the fact ; and, moreover, the scarcity is becoming much greater than it was even a few years ago. Such falling off in the supplies of certain kinds of fish is not peculiar to the Scottish or British coasts, since, for a considerable length of time, complaints of the depletion of the inshore fisheries have been heard in almost all countries where sea-fisheries are extensively prosecuted ; and active measures, by restrictive regulations, have in many instances been taken.

This unfortunate failure must be attributed to over-fishing by trawlers. In Scotland the regulative measures respecting beam-trawling are more extensive than in any other country, and have been longer in force ; yet, although the area from which this mode of fishing has been excluded is very large, it cannot be said, with the information at present available, that the anticipations formed of the results have been realized, for investigations indicate a continued diminution in the average abundance of the fish within these protected waters. In some parts of the world, however, as in the United States, Norway, Canada, and Newfoundland, another means has been adopted to meet the unsatisfactory conditions—each year to stock the exhausted grounds with millions of the young of fish, and, with this object in view, marine hatcheries have been erected for the artificial propagation of fish on a large scale. The readers of KNOWLEDGE are probably aware that, in carrying out the same policy, the Fishery Board for Scotland have recently established a similar institution at Dunbar. A short account of the institution may possibly be found of interest.

It has been modelled after the manner of the well-known one at Flödevig, near Arendal, Norway, and since its completion, early in the spring of last year, operations in the hatching of fishes have been in progress in it, under the supervision of Mr. Harald Dannevig, an expert from the Norwegian establishment. It stands chiefly within the park of the old castle of Dunbar. Dunbar was selected as a suitable site for several reasons, the principal of which were that the water was found to be well adapted for the hatching of buoyant fish-eggs, and natural sea-creeks, necessary for the full success of the undertaking, existed in the neighbourhood. This locality is likewise within convenient distance of important fishing-grounds, and of the sea-areas where most of the scientific fishery experiments have been made, and where, therefore, the influence of fish-hatching may best be ascertained.

I will aim merely at giving a general idea of the most interesting portions of the hatchery. First of all there comes the spawning-pond, where the spawning fishes are lodged when the work is going on. No observer can fail to be struck with the strength of this structure, which is formed of concrete, at a higher level than the other buildings, and sunk in the ground. Pumps, which draw from the harbour and the tidal-pond, supply it with sea water ; its capacity is more than 10,000 cubic feet, or about 62,000 gallons. It is enclosed by substantial

wooden walls, and covered in with a roofing of galvanized iron. On the bottom, lying loose on the concrete, there is a system—or rather two systems—of branched perforated piping, of diminishing diameter, each system occupying one half of the floor respectively, and connected with an outflow pipe; a contrivance to allow of the rapid drawing off of the bottom layer of water, which soonest becomes tainted, without unduly depressing the level of the water in the pond. Somewhat above these pipes a wooden platform is placed, spaces being left between the boards in order to permit waste matters to slip through, when they may be quickly removed in the manner indicated; on the flooring the flat fishes rest. As has been said, it is into this pond that the adult fishes are put at the spawning season, and they spawn naturally, as they would in the sea, merely needing to be fed, and furnished with water enough to preserve them in good health; and the eggs, rising towards the surface, are carried by the overflow into a compartment known as the "spawn collector," a filter or sieve that retains the eggs, while the water passes away.

The ova are lifted out by a haircloth tray—the use of bags of silk bolting-cloth is being tried—the process usually occupying some hours, and are then transferred to the hatching-boxes, where a constant current of pure sea-water is maintained through them.

The pre-eminent attraction of the whole establishment is, of course, the Dannevig hatching apparatus. They form the special feature in the Norwegian method. They consist of an oblong wooden box, divided into two series of seven water-tight compartments, by one central longitudinal and six transverse partitions. With the first and the last compartment in each series, those at the ends, the inflow and outflow pipes communicate; the other five compartments in each series are wider, and contain the hatching-boxes. With wooden sides and a bottom of haircloth, the latter are attached to the top of the transverse partition by leather hinges, and when the apparatus is full of water the free end floats up. The apparatus, each with its ten boxes, are arranged in pairs, four on each side of the apartment. On entering an apparatus the water falls into one of the narrow compartments, which communicates with its fellow, and upon both becoming full it overflows into the first pair of hatching-boxes, and through the haircloth bottom into the compartments in which they are contained; this overflows into the second pair of boxes, and so on, until the narrow compartments at the lower end are reached, whence it escapes by a waste pipe through the floor. The fact of the free edge of the box being floated up as the compartment becomes full of water, admits of the application of a special feature of Dannevig's system—the forcible depression of the box at intervals, which forces water up through the haircloth bottom. As the current passes in at the top it falls on the surface, but it alone is insufficient to maintain the buoyant eggs in a state of equal distribution throughout the mass of water, and unless an up-and-down movement is imparted to the boxes the eggs collect in a layer on the surface. The movement is accomplished by an iron rod, jointed to the upper end of the hatching apparatus, and passing down the middle between the boxes, and possessed of five short, transverse pieces, one for the free edges of each pair of boxes. Without going into details, suffice it to say that motion is conveyed to the rods, so that they are alternately slowly lifted from the boxes and allowed rather suddenly to fall upon them. When the rod is raised, the buoyancy of the boxes causes them to float up, as has been described, and when it falls it is weighted sufficiently to press them, and submerge them in the water, which rises through the perforated bottom.

By and by the fishes emerge from the eggs. The fry are kept in the hatching-boxes until the yolk-sac, from which they derive their nourishment in the early stage, is nearly absorbed, and they are able to eat; no attempt being made to feed them, they are transferred directly to suitable places in relation to the fishing-grounds, where they are liberated. Thus they are deposited in the sea while still in their larval state. At this period, it may be mentioned, the fry of flat fishes have not attained the characteristic appearance of their kind, but resemble those of round fishes, such as cod or haddock; the body is symmetrical, and the eyes are placed one on either side of the head; and it is only after the lapse of two months or so, which are spent in the surface waters, that they acquire the adult form and habits fitted for a bottom life, enabling them to secure protection by resemblance to the ground on which they lie, and by burrowing. There can be no doubt that great destruction of the young arises from natural causes during this period of pelagic life, and a great step in advance would be made were they artificially protected for the necessary time before planting them on the fishing-grounds; clearly, it would immensely increase the usefulness of the hatchery to the fishing industry. The fish at this stage are small, and multitudes could be dealt with. For the purpose, control must be had of a large body of water to form tidal ponds, and this lies ready to hand in the sea-creeks adjoining the hatchery. If enclosed, they would furnish admirable quarters for the rearing of many millions of fry simultaneously, and would afford a volume of pure sea-water exceeding half a million gallons.

This inclosure would also serve for the retention of large numbers of brood-fish, or spawners, which would be collected gradually before the actual hatching work begins, the small arm or inlet of one of the creeks which is now utilized, though it is very serviceable in this respect, being of insufficient size to store all the fishes required. At the hatcheries in the United States, Norway, and Newfoundland, ample accommodation of this sort has been provided.

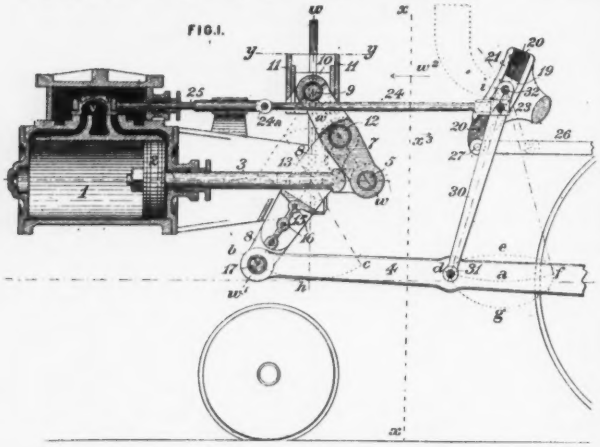
At these hatcheries the species of food-fish almost exclusively treated is the cod, which constitutes a very important element in the fisheries of those countries. But in Scotland the cod, though an important fish, is not the most valuable, nor is there definite evidence of the supply diminishing. On the contrary, it is the valuable flat-fishes, soles, lemon-soles, turbot, and plaice, that show unquestionable decrease, and it was therefore decided that with these fishes the hatching operations should be commenced at Dunbar.

The sixteen Dannevig apparatus there can together accommodate at one time about 80,000,000 cod eggs, and since, during the spawning season of any species, the hatching-boxes may be refilled at least twice, no fewer than about 160,000,000 cod eggs may be handled in the course of one season. Plaice eggs are larger, and perhaps only 100,000,000 could be hatched. The eggs of the sole are about the same size as those of the cod, those of the lemon-sole and turbot somewhat smaller, so that the working capacity of the hatchery in the year may be stated as equal to several hundred millions. About 92 gallons of water are requisite per hour for each apparatus, that is, for about 5,000,000 cod eggs, so that the supply for sixteen apparatus must be about 1500 gallons per hour, and adding 800 gallons for the spawning-pond, the total quantity for 80,000,000 cod eggs is 2300 gallons per hour. The pumps are, however, capable of throwing over 7000 gallons per hour, and thus by increasing the apparatus—an inexpensive proceeding compared with the cost of enlarging the water supply—the quantity of spawn that may be dealt with may be more than doubled.

XUM

Some Recent Patents.

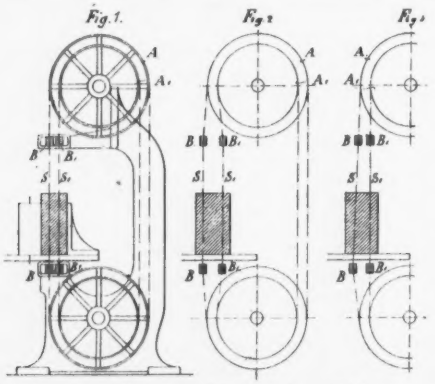
Matthias Nace Forney, New York, United States. Improvements in steam engines. This invention is more particularly designed for simple or single expansion engines, but is also applicable to compound engines, and its objects are to provide means for counterbalancing the momentum of reciprocating elements, one by another, without inducing disturbing action at right angles to the movement of such elements. The figure shows its application to a locomotive engine. 1 is the cylinder, 2 the piston, 3 the piston rod, the outer end being coupled to the primary lever, 7, one end of which is connected by a pin, 9, to a sliding block, 10, working in a fixed guide, 11. The lever,



7, is coupled by a pin, 12, to the upper ends of a pair of secondary levers, 8, 8. Instead of coupling the connecting rod, 4, directly to the end of the piston rod, it is coupled to the lower ends of the secondary levers, and its opposite end is coupled to an ordinary crank pin. The rod, 30, in combination with the reversing link, 20, governs the motions of the valve by the rod, 24, giving constant "lead," and variable expansion.

No. 20,808. *Dated 30th October*, 1894. *Accepted 27th January*, 1895. *Eight figures.*

Johann Anthon, of Flensburg, Germany. Improvements in or relating to band-saw machines. The object of this invention is to mount two or more band-saws upon two or more sets of pulleys, to



afford facilities for cutting boards of various thicknesses and at various angles. Fig. 1 shows two band-saws mounted on pulleys of different diameters, and Figs. 2 and 3 show methods of varying the saw cuts. The position of the lower axles of both the saw pulleys is fixed, but the axles of the upper saw pulleys, A and A^1, are mounted in separate bearings, so that each one of the saw-bands may be stretched independently of the other, in a vertical direction. The small pulley, A^1, is placed before the larger pulley, A, to enable the saw-band, S, to be lifted over the small pulleys. B B^1 are shifting guide blocks, capable of being independently moved to the right and left, so as to make parallel or inclined cuts, as required.

No. 9212. *Dated 9th May*, 1895. *Accepted 15th June*, 1895. *Seven figures.*

THE FACE OF THE SKY FOR AUGUST.

By Herbert Sadler, F.R.A.S.

SPOTS and faculæ are still visible in considerable numbers on the solar surface. There will be a partial eclipse of the Sun on the 20th, but it will only be visible in parts of Russia and Western Asia. Conveniently visible minima of Algol occur at 12h. 1m. P.M. on the 15th, and at 8h. 45m. P.M. on the 18th.

Mercury is visible as a morning star during the first portion of the month. On the 1st he rises at 2h. 55m. A.M., or one hour and a half before the Sun, with a northern declination of 21° 29′, and an apparent diameter of 6·0″, about $\frac{7}{10}$ths of the disc being illuminated. On the 5th he rises at 3h. 13m. A.M., or about one hour and a half before the Sun, with a northern declination of 20° 42′, and an apparent diameter of $5\frac{1}{2}''$, $\frac{84}{100}$ths of the disc being illuminated. On the 10th he rises at 3h. 47m. A.M., or 53m. before the Sun, with a northern declination of 18° 44′, and an apparent diameter of $5\frac{1}{4}''$, $\frac{95}{100}$ths of the disc being illuminated. After this he approaches the Sun too closely to be visible. He is in conjunction with Jupiter at 5h. P.M. on the 1st (this conjunction is not, of course, visible at Greenwich), Mercury being 9′ to the south, and in superior conjunction with the Sun on the 17th. While visible he describes a direct path in Cancer.

Venus is an evening star, and is theoretically at her greatest brilliancy on the 14th. She will, however, be too near the Sun to exhibit her full splendour. On the 1st she sets at 9h. P.M., or about an hour and a quarter after the Sun, with a northern declination of 1° 18′, and an apparent diameter of $31\frac{1}{2}''$, $\frac{84}{100}$ths of the disc being illuminated. On the 9th she sets at 8h. 29m. P.M., or 57m. after the Sun, with a southern declination of 1° 55′, and an apparent diameter of $35\frac{1}{2}''$, $\frac{3}{10}$ths of the disc being illuminated. On the 13th she sets at 8h. 12m. P.M., or about three-quarters of an hour after the Sun, with a southern declination of 3° 24′, and an apparent diameter of $37\frac{1}{2}''$, $\frac{26}{100}$ths of the disc being illuminated. After this she approaches the Sun too closely to be conveniently observed. While visible she describes a direct path in Virgo.

Mars is, for the observer's purposes, invisible.

The minor planet Vesta is in opposition to the Sun on the 25th, her magnitude at the present opposition being about equal to that of a $6\frac{1}{2}$ magnitude star. On the 1st she souths at 2h. 12m. A.M., with a southern declination of 16° 15′. On the 13th she souths at 1h. 17m. A.M., with a southern declination of 17° 56′. On the 25th she souths at 0h. 15m. A.M., with a southern declination of 19° 34′. During the month she describes a retrograde path in Aquarius. At 10h. P.M. on the 3rd she is 5 seconds preceding and $7\frac{1}{2}'$ south of the 3rd magnitude star δ Aquarii; at 9h. P.M. on the 18th she is in conjunction with the 5th magnitude star 66 Aquarii, $\frac{3}{4}°$ to the north; and at opposition she is about $1\frac{1}{2}°$ W.S.W. of that star and $1\frac{3}{4}°$ N.N.E. of υ Aquarii ($5\frac{1}{4}$ magnitude).

Jupiter is a morning star, but is too near the Sun for observation during the first portion of the month. On the 9th he rises at 2h. 33m. A.M., with a northern declination of 21° 26′, and an apparent equatorial diameter of $31\frac{1}{2}''$. On the 31st he rises at 1h. 36m. A.M., with a northern declination of 20° 35′, and an apparent equatorial diameter of $32\frac{1}{2}''$. The following phenomena of the satellites occur while the planet is more than 8° above and the Sun 8° below the horizon. On the 14th a transit ingress of the shadow of the first satellite at 3h. 28m. A.M.

On the 15th an occultation reappearance of the first satellite at 3h. 41m. A.M. On the 29th a transit egress of the shadow of the second satellite at 2h. 56m. A.M. On the 30th a transit egress of the shadow of the first satellite at 4h. 4m. A.M. While visible, Jupiter describes a short direct path on the confines of Gemini and Cancer.

Saturn is still visible, but must be looked for as soon after sunset as possible. On the 1st he sets at 10h. 33m. P.M., or about two hours and three-quarters after the Sun, with a southern declination of 9° 39′, and an apparent equatorial diameter of $16\frac{3}{4}''$ (the major axis of the ring-system being 38″ in diameter, and the minor $11\frac{1}{4}''$). On the 19th he sets at 9h. 25m. A.M., or about two and a quarter hours after the Sun, with a southern declination of 10° 5′, and an apparent equatorial diameter of $16\frac{1}{4}''$ (the major axis of the ring-system being $36\frac{3}{4}''$ in diameter, and the minor $10\frac{3}{4}''$). After this he gets too near the Sun to be conveniently observed. While visible, he describes a short direct path in Virgo, not far from $\varkappa$ Virginis.

Uranus has practically left us for the season, and in the case of Neptune we defer an ephemeris till September.

This month is one of the most favourable ones in which to observe shooting stars. The most noted shower is that of the Perseids, with a radiant point at the maximum display on August 10th, in R.A. 11h. 52m.—56°. Observations of this region with an opera glass will no doubt show stationary meteors, or meteors which shift their positions very slowly. Their places, and the direction of their shift, should be noted for the purposes of determining whether the radiant is a geometrical point, or a circle, or an elliptic area, as suggested with regard to the November meteors (*Monthly Notices of the Royal Astronomical Society*, Vol. XLVII., pp. 66-73). The radiant point souths at 5h. 37m. A.M.

The Moon is full at 1h. 51m. P.M. on the 5th; enters her last quarter at 5h. 19m. P.M. on the 13th; is new at 0h. 56m. P.M. on the 20th; and enters her first quarter at 5h. 43m. A.M. on the 27th. She is in apogee at 7h. P.M. on the 7th (distance from the earth 252,320 miles), and in perigee at 9h. P.M. on the 20th (distance from the earth 222,100 miles). At 2h. 51m. A.M. on the 5th the 6th magnitude star 17 Capricorni will make a near approach to the lower limb at an angle of 331°. At 0h. 25m. A.M. on the 7th the 6th magnitude star 42 Aquarii will disappear at an angle of 73°, and reappear at 1h. 41m. A.M. at an angle of 214°. At 1h. 44m. A.M. on the 8th the 6th magnitude star 81 Aquarii will disappear at an angle of 60°, and reappear at 3h. 2m. A.M. at an angle of 222°; and at 3h. 17m. A.M. the 6th magnitude star 82 Aquarii will disappear at an angle of 10°, and reappear at 4h. 14m. A.M. at an angle of 274°. At 9h. 11m. P.M. on the 12th the $6\frac{1}{2}$ magnitude star B.A.C. 782 will disappear at an angle of 52° (the star being below the horizon at the time), and reappear at 10h. 1m. P.M. at an angle of 261°. At 1h. 44m. A.M. on the 13th the $5\frac{1}{2}$ magnitude star μ Arietis will disappear at an angle of 22°, and reappear at 2h. 38m. A.M. at an angle of 278°; and at 10h. 51m. P.M. the $6\frac{1}{2}$ magnitude star 66 Arietis will make a near approach to the lunar limb at an angle of 159°. At 3h. 3m. A.M. on the 16th the $6\frac{1}{2}$ magnitude star B.A.C. 1746 will disappear at an angle of 156°, and reappear at 3h. 17m. A.M. at an angle of 184°. At 9h. 12m. P.M. on the 27th the $6\frac{1}{2}$ magnitude star B.A.C. 1746 will disappear at an angle of 85°, and reappear (below the horizon) at an angle of 279°. At 6h. 23m. P.M. on the 30th the 6th magnitude star B.A.C. 6666 will disappear (in bright sunlight) at an angle of 50°, and reappear at 7h. 35m. P.M. at an angle of 289°.

Chess Column.

By C. D. LOCOCK, B.A.Oxon.

Communications for this column should be addressed to C. D. LOCOCK, Burwash, Sussex, and posted on or before the 12th of each month.

Solutions of July Problems.

No. 1.—(By C. D. Locock.)

1. Q to KKt7, and mates next move.

CORRECT SOLUTIONS received from H. S. Brandreth, Alpha, W. O. Brigstocke, G. G. Beazley, Dr. Hardwick, E. W. Brook, W. Willby, J. T. Blakemore, A. G. Fellowes, and A. Louis.

No. 2.—(By A. F. Mackenzie.)

Key-move.—1. R to K5.

1. . . . B × R. 2. R to QKt5.
1. . . . Kt moves. 2. R to Q5ch.
1. . . . P to K6. 2. R × Kt mate.
1. . . . R × P. 2. R × Pch.

CORRECT SOLUTIONS received from H. S. Brandreth, W. O. Brigstocke, E. W. Brook, W. Willby, J. T. Blakemore, and A. Louis.

A. G. Fellowes.—Many thanks. They appear below. Glad to hear of your continued successes.

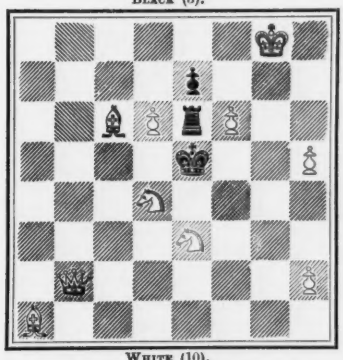
W. O. Brigstocke.—Your inquiry having been accidentally neglected, you are credited with solution of the three-mover. The solution, of course, has been previously published elsewhere.

Alpha.—If 1. R to QKt5, P to K4, and there is no mate in two moves.

PROBLEMS.

By A. G. FELLOWES.

BLACK (3).

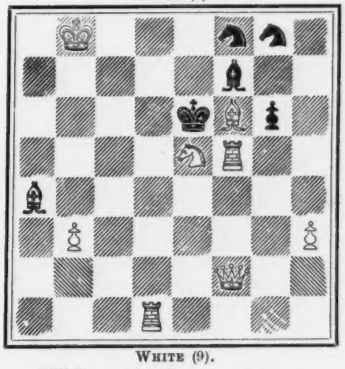


WHITE (10).

White mates in two moves.

No. 2.

BLACK (5).



WHITE (9).

White mates in two moves.

[The foregoing problems by our valued correspondent obtained respectively first prize and honourable mention in the recent problem tourney of the *Birmingham Weekly Mercury*.]

The score of the following game is taken from the *Standard*.

"French Defence."

White. E. Sobernheim.	Black. S. Langleben.
1. P to K4	1. P to K3
2. P to Q4	2. P to Q4
3. Kt to QB3	3. Kt to KB3
4. B to Kt5	4. B to K2
5. B×Kt	5. B×B
6. P to K5	6. B to K2
7. Q to Kt4	7. Castles
8. B to Q3	8. P to KB4 (*a*)
9. Q to R3 (*b*)	9. P to B4
10. P×P	10. Kt to Q2
11. P to B4	11. Kt×BP
12. Castles	12. P to QKt4
13. B×KtP (*c*)	13. R to Ktsq
14. Kt to B3	14. P to QR3
15. B to Q3 (*d*)	15. Q to Kt3
16. P to QKt3	16. Q to Kt5
17. K to Kt2 (*e*)	17. Q to R6ch
18. K×Q (*f*)	18. Kt×Bdisch
19. P to Kt4	19. R×P
20. R×Kt	20. R to Kt8disch
21. K to R4	21. B to Q2ch
22. K to R5	22. B to Qsqch
23. K×P	23. B to Bsqch
24. K to R7	24. B to Kt3ch
25. K to R8	25. B to R3 mate.

Notes.

(*a*) Best, for if 8. . . . P to QB4 instead, White by 9. Q to R3 compels 9. . . . P to KKt3 instead of P to KB4.

(*b*) We are inclined to prefer 9. Q to K2, in order to leave the KP protected after the QP is exchanged. The move made, however, is the "book" move.

(*c*) An injudicious capture which exposes him to a strong attack. He should play instead 13. KKt to K2.

(*d*) The *Standard* prefers 15. B to R4. We should incline to 15. B to B4, whence the Bishop can retire to Kt3 when necessary.

(*e*) This gives Black the opportunity of bringing about a very elegant finish. 17. Kt to QKtsq was the correct defence.

(*f*) If the King moves 18. . . . Kt×P, 19. P×Kt, R×P wins. The ending is both forcible and problem-like.

CHESS INTELLIGENCE.

The following is the official list of entries for the Hastings International Tournament, which begins on August 5th:—America—Steinitz, Albin, and Pillsbury. Austria—Marco and Schlecter. Canada—Pollock. England—Lasker, Blackburne, Bird, Burn, Gunsberg, Mason, Teichmann and Tinsley. France—Janowski. Germany—Tarrasch, Bardeleben, Mieses, and Walbrodt. Italy—Vergani. Russia—Tchigorin and Schiffers. We have no hesitation in saying that these select twenty-two will be the strongest body of competitors that have ever taken part in any tournament. The most notable absentees are Lipke, Makovetz and Winawer; otherwise, the list could hardly be improved. Dr. Tarrasch is now playing a return match with Walbrodt at Nuremberg. This should be good practice for both players. The chief interest in the tournament will lie in the places taken by Lasker, Steinitz and Tarrasch, who may be expected to take at least two of the highest prizes between them. The scoring should be very even with so strong a list, and we should not be surprised to see the first prize taken with a score of sixteen, and the last place but one with a score of seven. Players with a tendency to draw, such as Walbrodt, Marco, Schlecter, Bardeleben, etc., are not likely to come out either near the top or at the bottom of the list. But further prophecy will become easier after the event.

The result of the Amateur Tournament at Craigside, Llandudno, arrived just too late for publication last month. The entries were few in number, but of good quality. The challenge cup was won by Mr. E. O. Jones, with the fine score of four wins, no draws or losses. Messrs. J. H. Blake, Herbert Jacobs (the previous holder), and the Rev. J. Owen tied for the other prizes with scores of two. Mr. Owen could have won the second prize outright had he accepted the draw offered by Mr. Jones. The handicap tourney was also won by Mr. Jones with a score of six clear wins. Altogether it seems to have been Mr. Jones' week. His portrait and biography appear in the July number of the *Chess Monthly*.

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Three Plates.—1, The Giant Sand-Scorpion of Namaqualand; 2, Parts I. and II. of the Great Nubecula.

NOTICES.

The numbers of Knowledge for January and February of last year can now be had, price One Shilling each.

Bound volumes of Knowledge, New Series, can be supplied as follows:—Vols. I., II., and III., 10s. 6d. each; Vols. VI., VII., VIII. (1893), and IX. (1894) 8s. 6d. each.

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